2011 VERMONT RELATIVE MATURITY CORN SILAGE TRIALS

In 2011, the University of Vermont Extension conducted an experiment to evaluate yield and quality of corn hybrids with a range of relative maturities. The goal is to document the best range of corn silage maturities to grow in this area to maximize corn yield and quality. It is important to remember that the data presented are from a single trial at only one location. Hybrid-performance data from additional trials in different locations and often over several years should be compared before conclusions are drawn.

MATERIALS AND METHODS

Corn varieties of differing maturities were evaluated at Borderview Research Farm in Alburgh, VT for yield and quality performance. Several seed companies submitted varieties for evaluation. Companies and contact names are listed in Table 1. Twenty-five corn hybrids ranging in maturities from 87-114 days were grown at this site. The Relative Maturity (RM) and traits of each variety is provided by the companies and is listed in Table 2.

Table 1. Participating companies and local contact information

Dekalb/Monsanto	Mycogen	Pioneer
Klaus Busch Territory Sales Manager Knox, NY 518-320-2462	Claude Fortin District Sales Manager Highgate, VT 802-363-2803	Jacob Bourdeau Bourdeau Bros. Sheldon, VT 802-933-2277
Seedway	**Wolf River Valley Seeds**	
Ed Schillawski 3442 Rt 22A Shoreham, VT 802-897-2281	Marcel Moreau District Sales Manager Swanton, VT 802-309-4674	

Table 2. Corn silage hybrids, relative maturity (RM) and traits.

Company	Hybrid	RM	Traits
Wolf River	2087L	87	Leafy
Wolf River	2290GT	90	GT
Dekalb	DKC44-92	94	RR2
Mycogen	TMF2L418	94	HXT, RR2, LL
Dekalb	DKC45-51	95	GENSS
Dekalb	DKC46-07	95	YG, VT3
Dekalb	DKC46-61	96	GENSS
Mycogen	TMF2N494	97	RR2
Seedway	SW3788VT3	97	VT3
Dekalb	DKC48-12	98	GENSS
Dekalb	DKC48-40	98	RR2
Seedway	39041L	98	Leafy
Dekalb	DKC50-77	100	GENVT3P
Mycogen	TMF2L533	101	HXT, RR2, LL
Seedway	4704RR	102	RR2
Dekalb	DKC53-45	103	GENSS
Seedway	5501L	106	Leafy
Wolf River	2114L	106-108	Leafy
Seedway	SW6414RR	108	RR2
Seedway	6601L	108	Leafy
Pioneer	34A89	109	HXT, RR2, LL
Mycogen	TMF2Q717	109	SSX, RR2, LL
Pioneer	P1011AM1	110	AM1, LL, RR2
Mycogen	TMF2W727	113	HXT, RR2, LL
Pioneer	33F88	114	HXT, RR2, LL

AM1 - Optimum® AcreMax® 1 Insect Protection System with an integrated corn rootworm refuge solution.

GENSS – Genuity® SmartStax™ controls corn earworm, fall armyworm, northern corn rootworm, western bean cutworm, European corn borer, black cutworm, and southwestern corn borer. Also contains resistance to Roundup Ready® Corn 2 and LibertyLink® herbicides

GT – Glyphosate herbicide (Roundup®, Touchdown®) tolerant.

HXT – Herculex Xtra® (Mycogen brand), provides season-long control of a variety of pests, including European corn borer, western bean cutworm, corn rootworm, and black cutworm.

LL – LIBERTY LINK CORN® is tolerant to broadcast applications of Liberty® or Ignite® herbicide, glufosinate ammonium

GENVT3P - Genuity® VT Triple PRO™ is similar to YieldGard VT Triple but contains a second caterpillar gene that for the first time provides very good control of corn earworm in the ear and prevents most kernel damage by this insect.

RR2 – ROUND-UP READY 2® Technology is resistant to the herbicide glyphosate (Roundup®, Touchdown®), a post-emergent, foliar applied, non-selective.

SSX – SmartStax corn provides a broad spectrum of insect control, using multiple modes of action, as well as glyphosate herbicide (Roundup Ready®, Touchdown®) and glufosinate-ammonium (LibertyLink®) tolerance.

VT3 – YieldGard VT Triple™ uses VecTran™ technology which stacks insect- and weed-control traits in one variety. Provides glyphosate herbicide tolerance, as well as protection against western corn rootworms, northern corn rootworms, European corn borers, black cutworms, stalk borers, wireworms, white grubs, seed corn maggots, early flea beetles, and corn earworms

YG – YieldGard® against corn borer; YGCRW – YieldGard® against corn rootworm : YGVT3 – YieldGard VT Triple® insect protection trait controls western corn rootworms, northern corn rootworms, European corn borers, black cutworms, stalk borers, wireworms, white grubs, seed corn maggots, early flea beetles, and corn earworms-2000).

The trial seedbed was prepared with conventional tillage methods. The previous crop was corn. Starter fertilizer was applied at a rate of 260 lbs ac^{-1} of 10-20-20. Plots were planted with a John Deere 1750 4-row corn planter on May 26th and 31st, 2011 at 34,000 seeds to the acre. A rainstorm during the initial planting date delayed further planting until the soil had dried on 31-May. The soil type was a Benson silt loam. The plot design was a randomized complete block with two replications and the plots were 5'x30'. Treatments were varieties. Cinch ATZ Lite(S-Metolachlor, Atrazaine) at 3 pints $acre^{-1}$ and Accent (Nicosulfuron) at 3/4 oz $acre^{-1}$ were sprayed post emergence for weed control. When corn reached the V6 growth stage it was topdressed with 470 lbs ac^{-1} of 21-0-0. The plots were harvested on September 26th and October 10th, 2011, depending on maturity with a John Deere 2 row chopper, and the forage wagon was weighed on a platform scale in order to calculate yield. A subsample was collected for moisture determination and quality analysis. Pertinent trial information is summarized in Table 3. All data was analyzed using a mixed model analysis where replicates were considered random effects. The LSD procedure was used to separate cultivar means when the F-test was significant ($P< 0.10$).

Table 3. General plot management of the RM corn trial.

Trial Information	Alburgh, VT
Soil type	Benson Silt loam
Previous Crop	Corn
Row Width (in.)	30
Seeding rate (seeds/acre)	34,000
Planting date	26-May & 31-May
Harvest date	26-Sept. & 10-Oct.
Harvest area (ft.)	5 x 30
Tillage operations	Spring disk, harrow, spike-toothed harrow
Starter fertilizer	260 lbs ac^{-1} 10-20-20
Other fertilizer	470 lbs ac^{-1} 21-0-0
Herbicide	3 pints ac^{-1} Cinch ATZ Lite & ¾ oz ac^{-1} Accent

Silage quality was analyzed using Near Infrared Reflectance (NIR) spectroscopy at Cumberland Valley Analytical Services in Hagerstown, Maryland. The frozen samples were shipped to their forage testing facility where they were dried, ground and analyzed for crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), 30hr digestible NDF (dNDF), and starch. Mixtures of true proteins, composed of amino acids, and nonprotein nitrogen make up the CP content of forages. The CP content of forages is determined by measuring the amount of N and multiplying by 6.25. The bulky characteristics of forage come from fiber. Forage feeding values are negatively associated with fiber since the less digestible portions of plants are contained in the fiber fraction. The detergent fiber analysis system separates forages into two parts: cell contents, which include sugars, starches, proteins, non-protein nitrogen, fats and other highly digestible compounds; and the less digestible components found in the fiber fraction. The total fiber content of forage is contained in the neutral detergent fiber (NDF). Chemically, this fraction includes cellulose, hemicellulose, and lignin. Because of these chemical components and their association with the bulkiness of feeds, NDF is closely related to feed intake and rumen fill in cows. Recently, forage testing laboratories have begun to evaluate forages for NDF digestibility. Evaluation of forages and other feedstuffs for NDF digestibility is being conducted to aid prediction of feed energy content and animal performance. Research has demonstrated that lactating dairy cows will eat more dry matter and produce more milk when fed forages with optimum NDF digestibility. Forages with increased NDF digestibility will result in higher energy values, and perhaps more importantly, increased forage intakes. Forage NDF digestibility can range from 20 – 80%.

The silage performance indices of milk per acre and milk per ton were calculated using a model developed by researchers at the University of Wisconsin. Milk per ton measures the pounds of milk that could be produced from a ton of silage. This value is generated by approximating a balanced ration meeting animal energy, protein, and fiber needs based on silage quality. The value is based on a standard cow weight and level of milk production. Milk per acre is calculated by multiplying the milk per ton value by silage dry matter yield. Therefore milk per ton is an overall indicator of forage quality and milk per acre an indicator of forage yield and quality. Milk per ton and milk per acre calculations provide

relative rankings of forage samples, but should not be considered as predictive of actual milk responses in specific situations for the following reasons:

1) Equations and calculations are simplified to reduce inputs for ease of use,
2) Farm to farm differences exist,
3) Genetic, dietary, and environmental differences affecting feed utilization are not considered.

Results for the maturity variety trial are listed in Table 5. Dry matter yields were calculated and then adjusted to 35% dry matter for the report. CP, ADF, NDF, and starch are reported on a dry matter basis, and dNDF is reported on a % NDF basis. The numbers presented in the tables are of two replications. A figure is included to report yields in order of relative maturity (Figure 1). There is a figure displaying the relationship between milk per ton and milk per acre (Figure 2). The dotted lines dividing the figure into four quadrants represent the mean milk per ton and acre for the location. Therefore hybrids that fall above the lines performed better than the average and hybrids below the lines performed below average.

Variations in yield and quality can occur because of variations in genetics, soil, weather, and other growing conditions. Statistical analysis makes it possible to determine whether a difference among hybrids is real or whether it might have occurred due to other variations in the field. At the bottom of each table a LSD value is presented for each variable (i.e. yield). Least Significant Differences (LSD's) at the 0.10 level of significance are shown. Where the difference between two hybrids within a column is equal to or greater than the LSD value at the bottom of the column, you can be sure that for 9 out of 10 times, there is a real difference between the two hybrids. Hybrids that were not significantly lower in performance than the highest hybrid in a particular column are indicated with an asterisk. In the example below hybrid A is significantly different from hybrid C but not from hybrid B. The difference between A and B is equal to 1.5 which is less than the LSD value of 2.0. This means that these hybrids did not differ in yield. The difference between A and C is equal to 3.0 which is greater than the LSD value of 2.0. This means that the yields of these hybrids were significantly different from one another. The asterisk indicates that hybrid B was not significantly lower than the top yielding hybrid C.

Hybrid	**Yield**
A	6.0
B	7.5*
C	**9.0***
LSD	**2.0**

RESULTS

Seasonal precipitation and temperatures recorded at a weather station in close proximity to the 2011 research site are shown in Table 4. The 2011 growing season had a wide range of weather extremes. In May, 8.67 inches of rain fell, 5.35 inches above the 30 year average. This additional moisture made planting difficult, compacted soils, and affected corn emergence. During June and July, low rainfall amounts and higher than normal temperatures caused the corn to show signs of drought stress. On August 28, 2011 tropical storm Irene hit the region dropping several inches of rain and creating wind gusts over 70 mph at the trial site. The high winds caused significant lodging in some plots. This year accumulated 2789 Growing Degree Days (GDD), 358 more than the 30 year average. GDDs are reported using base 50° – 86°F.

Table 4. Temperature, precipitation, and growing degree days summary – Alburgh, VT

South Hero (Alburgh)	May	June	July	August	September	October
Average Temperature (F)	58.7	67.1	74.4	70.4	63.8	51.5
Departure from Normal	2.1	1.3	3.3	1.6	5.8	4.5
Precipitation (inches)	8.67	3.52	3.68	10.23	5.56	2.68
Departure from Normal	5.35	0.09	-0.29	6.38	2.10	0.10
Growing Degree Days (base 50)	259.5	513.0	732.0	562.7	391.5	330.0
Departure from Normal	-0.9	39.0	79.5	-27.0	79.5	227.7

Based on National Weather Service data from cooperative observer stations in South Hero. Historical averages are for 30 years of data (1971

Plant populations differed greatly among the hybrids. Poor early season weather conditions led to below average germination. In addition, high winds and raccoons led to lodging in several of the plots. Interestingly, the higher plant population did not always result in higher yields. However, this factor would obviously play a role in the final yield of the variety.

There was no significant difference among hybrids in silage yields. The highest yielding was the Seedway hybrid 39041L (98 RM), 22.7 tons ac^{-1}. The lowest yielding hybrid was Mycogen TMF2L418 (94 RM), 14.0 tons ac^{-1} (Table 5 and Figure 1). The average yield across all varieties was 17.8 tons ac^{-1}. There was no relationship between RM and yield. The weather conditions caused a significant amount of stress on the corn plants during 2011. The amount of variability from plot to plot was high due to changes in soil type, wind patterns, and raccoon damage. This environmental variability was likely the reason why few statistical differences were seen among the varieties in the trial.

There were significant quality differences detected among the hybrids in the trial (Table 5). Crude protein, ADF, NDF, and starch were statistically different among hybrids. The highest CP concentrations ranged from 7.55 to 8.15 %. Lowest NDF concentrations ranged from 31.4 to 35.8%. There was no difference in dNDF among the varieties. The Nel was highest in Wolf River 2290GT at 0.80 Mcal/lb but was not statistically different from other varieties with Nel values between 0.78 and 0.79 Mcal/lb.

Table 5. Yield and quality of corn silage hybrids ranging in maturity from 87-114 RM.

Company	Hybrid	Relative		DM at	Plant	Yield		Forage Quality Characteristics							Milk per	
		maturity		harvest	density	35% DM		CP	ADF	NDF	dNDF	Starch	Nel		ton	acre
				%	plants/acre	T/A		%	%	%	%	%	Mcal/lb			
Wolf River	2087L	87		40.3	31015*	12.2		**8.15***	28.3	48.2	57.7	26.2	0.72		2849	12190
Wolf River	2290GT	90		42.8	35196*	14.5		7.30	**19.0***	**31.4***	59.6	**44.6***	**0.80***		3099	15848
Dekalb	DKC44-92	94		35.9	29098*	15.6		6.80	22.9	38.1	59.5	36.8	0.77		3351*	18275
Mycogen	TMF2L418	94		37.5	23522	14.0		8.05*	22.3	37.4	61.9	35.8	0.78*		3370*	16504
Dekalb	DKC45-51	95		36.3	33106*	15.8		6.55	23.7	38.0	58.7	37.7	0.77		3285*	18155
Dekalb	DKC46-07	95		40.4	32931*	17.6		7.35	20.6*	34.4*	60.4	41.3*	0.79*		3185	19579
Dekalb	DKC46-61	96		39.3	35022*	18.8		6.70	23.0	38.2	60.0	38.1	0.77		3198*	21117
Seedway	SW3788VT3	97		40.9	31886*	18.7		7.00	22.5	37.2	56.7	39.1	0.78*		3064	20176
Mycogen	TMF2N494	97		39.2	34674*	18.7		7.25	22.5	36.4	**62.0**	37.4	0.78*		3206*	21091
Seedway	39041L	98		43.2	32583*	**22.7**		7.75*	22.7	38.3	59.3	35.4	0.77		3045	24098
Dekalb	DKC48-12	98		38.6	32409*	19.3		6.95	22.9	36.8	57.6	38.0	0.77		3080	20877
Dekalb	DKC48-40	98		39.4	**35371***	14.7		7.30	21.2*	35.2*	55.5	39.6*	0.78*		3181	16306
Dekalb	DKC50-77	100		**47.7***	26136	17.9		7.30	21.5*	36.1	56.0	40.8*	0.78*		2832	17812
Mycogen	TMF2L533	101		47.0*	31015*	19.6		7.35	21.1*	37.7	55.4	40.7*	0.79*		2957	20320
Seedway	SW4704RR	102		45.9*	27181*	17.0		**8.15***	20.8*	35.6*	57.9	40.6*	0.79*		3019	17988
Dekalb	DKC53-45	103		44.0	28053*	21.0		7.30	23.5	39.5	57.2	37.2	0.76		2827	20776
Seedway	SW5501L	106		38.5	15507	15.2		8.05*	21.9	39.2	61.0	36.8	0.77		**3421***	18223
Wolf River	2114L	106-108		38.1	25091	19.8		7.80*	23.7	40.8	57.7	35.6	0.77		3285*	22695
Seedway	6601L	108		38.0	26310	18.9		8.05*	23.8	42.2	60.2	34.7	0.76		3402*	22518
Seedway	SW6414RR	108		37.8	20909	14.9		7.70*	21.2*	35.8*	57.6	39.1	0.78*		3343*	17440
Pioneer	34A89	109		37.4	25091	18.6		7.80*	23.5	40.8	59.4	34.4	0.76		3341*	21760
Mycogen	TMF2Q717	109		37.3	22651	21.6		8.10*	23.3	38.0	56.5	36.2	0.77		3233*	**24526**
Pioneer	P1011AM1	110		37.1	26659	18.5		7.75*	24.6	41.2	57.8	33.6	0.76		3265*	21103
Mycogen	TMF2W727	113		36.0	25613	19.4		7.55*	25.3	41.5	56.8	31.5	0.76		3326*	22562
Pioneer	33F88	114		37.2	27704*	19.3		7.65*	21.1*	35.7*	58.6	38.5	0.79*		3408*	22976
*LSD (0.10)***				3.16	8213	NS		0.68	2.82	4.47	NS	5.1	0.02		230	NS
Trial Mean				39.8	28589	17.8		7.51	22.7	38.1	58.4	37.2	0.77		3183	19796

* Corn that did not perform significantly lower than the top performing variety in a particular column is indicated with an asterisk.

NS, no significant differences observed among the varieties in that particular column.

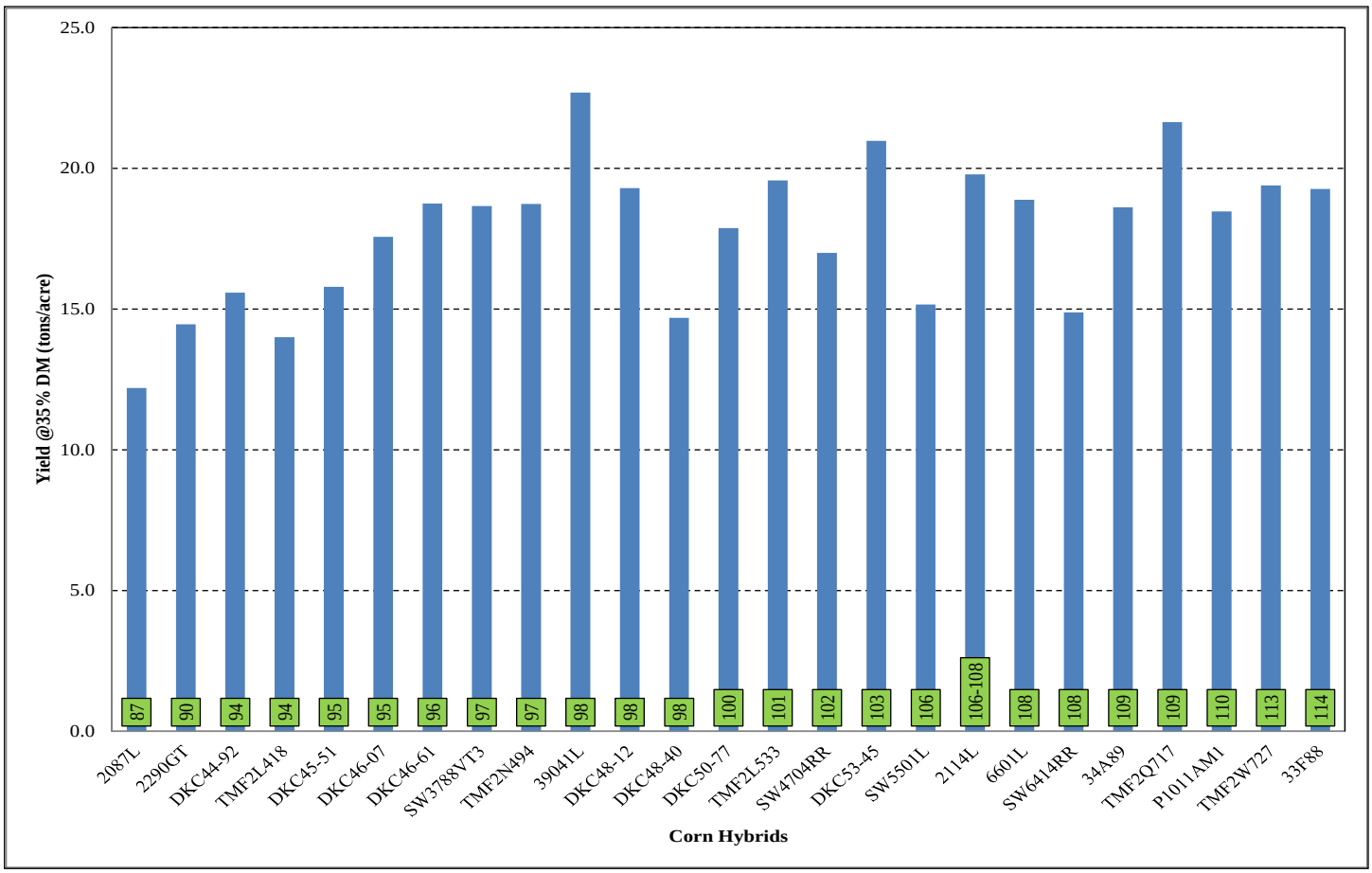

Figure 1. Yield comparison of corn silage hybrids ranging in maturity from 87 to 114 RM. ***Hybrids did not differ statistically in yield.***

Milk per ton was significantly different between hybrids (Table 3). Hybrids with a milk per ton range between 3421 and 3198 lbs of milk per ton of silage ranked at the top of trial (Table 5). Overall there were several varieties that were above average in both yield and quality (Figure 2). These varieties ranged between 96 and 114 RM.

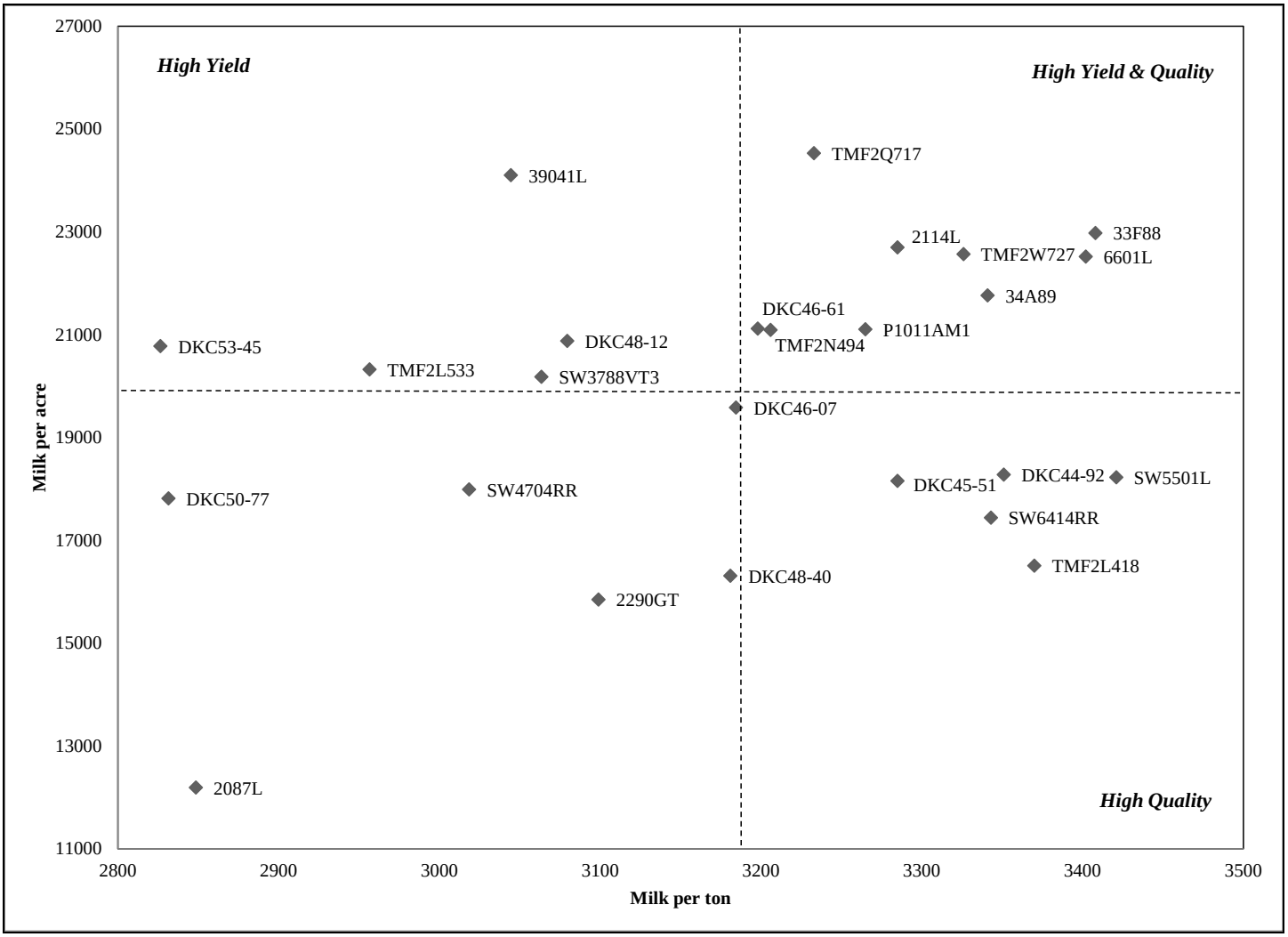

Figure 2. Milk performance of corn silage varieties. ***Dotted lines indicate overall milk per ton and milk per acre means of the corn varieties.***

DISCUSSION

As seen in previous years there was no relationship between corn silage yield and corn silage relative maturity. The extra GDDs accumulated this season allowed all varieties regardless of maturity to reach proper stage for silage harvest. Some varieties were harvested past optimum maturity due to late season rains. Overall the shorter season hybrids reached appropriate harvest dry matters up to two weeks earlier than some of the late season hybrids. An earlier harvest without yield and quality compromise would result in an opportunity for earlier manure application, cover cropping, and fall tillage. Although all the hybrids survived tropical storm Irene the full impact of the extreme weather in 2011 was obvious in both reduced stands and low yields.

Again hybrid selection should be based on the goals of each individual farm. Data from local trials should be evaluated to determine what will perform best in your growing climate. Hybrids should also be selected on more than maturity alone. As obvious from the report 98 RM hybrids can perform significantly different in both yield and quality. The three 98 RM varieties in this trial yielded between 14.7 and 22.7 tons per acre.

ACKNOWLEDGMENTS

UVM Extension would like to thank Roger Rainville and staff at Borderview Farm for their help implementing the trial. We would also like to thank Klaus Busch of Dekalb, Claude Fortin of Mycogen, Marcel Moreau of Wolf River Valley, Ed Schillawski of Seedway, and Dave Kostyo of Pioneer for the hybrid seed donation.