

**Evaluation of Corn Hybrids Grown for Silage  
in a Dairy System using CNCPS 4.0**

Greg W. Roth<sup>1</sup>, Charles J. Sniffen<sup>2</sup>, and Everett. D. Thomas<sup>2</sup>

**William H. Miner Agricultural Research Institute  
P.O. Box 90, Chazy, NY 12921**

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<sup>1</sup> Penn State University and <sup>2</sup> W.H. Miner Agricultural Research Institute

## **Introduction**

During the past decade, considerable effort has been spent developing or positioning commercial corn hybrids for use as silage on dairy farms. This has led to ratings of conventional hybrids for whole plant digestibility, and cell wall digestibility and to the development of commercial brown midrib (BMR) and leafy hybrids intended for silage use only.

The decision to use a silage specific hybrid on a dairy operation is a complex one. There is a wide range of differences in yield, fiber content, digestibility, and NDF digestibility among hybrids (Lauer et al., 2000, Thelen et al., 2000), with BMR hybrids often yielding significantly less than conventional or leafy hybrids, but having much higher NDF digestibility. These traits can also vary among normal and leafy hybrids. Seed costs also can vary significantly from \$15/acre for low cost silage blends to \$35/acre for many conventional hybrids to over \$90/acre for some of the BMR hybrids.

Feeding trials have shown that in some cases the BMR hybrids have resulted in higher dry matter intake (DMI) and milk production. (Oba and Allen, 1999). At the Miner Institute, one feeding trial comparing a conventional, leafy and BMR hybrid showed an advantage of 4.8 lb/hd/d in milk production for the BMR hybrid compared to a conventional hybrid (Ballard, et al. 2001). Oba and Allen (1999) reported that much of the benefit from a BMR hybrid was due to improvements in DMI associated with more rapid digestibility of forage Neutral Detergent Fiber (NDF).

Other feeding trials involving leafy hybrids have been less consistent, with several showing no increases in milk production (Ballard et al, 2001; Kuehn et al., 1999; Moreira et al., 2000) compared to normal hybrids. A trial conducted at the Miner Institute found a milk response of 3.7 lb FCM/hd/day when a leafy hybrid with superior whole plant and NDF digestibility was compared to a normal hybrid (Thomas et al., 2001).

Some of the variation in responses among trials may be attributed to differences in management, rations or to the production level of the cows. An alternative to conducting feeding trials would be to estimate the impact of differences in forage quality using a dairy nutrition model. Recently, Cornell University released CNCPS (Cornell Net Carbohydrate and Protein System) 4.0 (Fox et al. 2000), a dairy nutrition model that is designed to evaluate rations based on forage quality and animal performance criteria. Another model for evaluating differences in yield and quality among forages is the Milk2000 spreadsheet recently developed at the University of Wisconsin (Shaver et al., 2000).

The objectives of this study were 1) to evaluate the effect on milk production and economics for three hybrids with varying yield and forage quality attributes, 2) compare our results to those obtained using Milk 2000, and 3) assess the sensitivity of the CNCPS 4.0 model to changes in NDF digestibility.

## **Materials and Methods**

In 2000, we conducted a field study to evaluate the yield and forage quality differences among two conventional, two leafy and one BMR corn hybrid. Yield and forage quality samples were obtained from a field trials conducted at three locations in Pennsylvania. The initial forage quality analyses consisting of acid detergent fiber, NDF, crude protein, soluble sugars, ash, starch, *in vitro* whole plant digestibility and NDF digestibility were performed by Pioneer Hi-bred International at the Livestock Nutrition Center. The results of these trials are shown in the Appendix.

Three of the hybrids were selected for further analysis and the subsequent simulations: Pioneer 38T27 (conventional), Mycogen 2424 (leafy), and Cargill F277 (BMR). Estimates of lignin, neutral detergent indigestible protein (NDI-CP), acid detergent indigestible protein (ADI-CP) and soluble protein were determined on selected samples of these hybrids by the Rumen Profiling Laboratory at West Virginia University.

Forage quality inputs that were not available were set to the default values. The available fiber digestion rates (CHO:B2) for each hybrid were estimated using the CPM 2.0 dairy nutrition model. The NDF digestibility and lignin composition values for each hybrid were used in sample rations. Carbohydrate digestion rates were then adjusted for each hybrid to achieve similar passage rates for each of the three rations. These rates were then used in the CNCPS simulation for each hybrid. Yield and forage quality parameters of three of the hybrids representing the different hybrid types are shown in Table 1.

We then used the CNCPS 4.0 simulate production and cost of milk production for the high producing and mid to low producing lactating cow groups for the Miner Institute herd. The simulation was based on the ration used in the herd in December 2000. Characteristics of each group of animals and each feed and forage in the inventory were entered into the model. Dry matter intake, milk production and weight gains of each group were also utilized. In general, there was good agreement between the actual production and the predicted production data from the CNCPS 4.0 model.

In our simulation we assumed these hybrids would be completely substituted for each other in the ration. The ration for the two groups is shown in Table 2. Differences in the rations including the three corn hybrids are shown in Table 3. Differences among the rations were generally small since the differences among corn hybrids were diluted by other components in the ration.

We estimated costs for each of the forages and purchased feeds based on purchase prices and typical costs of production. The cost of production for corn for silage included the variation in seed costs and the relative yields obtained from the field trials we conducted at three locations. We assumed similar seed costs for the conventional and leafy hybrids, and \$55/acre higher costs for the BMR. In these trials, we measured yields of 7.03, 6.68, and 5.42 tons dry matter/A for the conventional, leafy and BMR hybrids. We assumed a base cost of production of \$305 per acre for the conventional and leafy silage and \$360/acre for the BMR silage. This resulted in cost of production for the conventional, leafy and BMR silages of \$45.80, \$48.06 and \$69.94/ton DM. We then assumed a 15% loss during harvest and storage. This resulted in costs of production as fed for the conventional, leafy and BMR silages of \$53.88, \$56.54 and \$82.28/ton DM,

respectively.

We used this base information to simulate production and cost of milk production for the high producing and mid to low producing lactating cow groups for the Miner herd. We developed a simulation for each hybrid type, a simulation for increased intake with the BMR hybrid, and a simulation with a combination of increased intake and lower production costs for the BMR and leafy hybrids.

We also conducted simulations assuming an increased intake potential for the BMR and leafy hybrids. These were based on the increase in intake that Oba and Allen (1999) observed with a BMR hybrid of 8.9% at a 44% inclusion rate. In our study with a 17% corn silage inclusion rate, the proportional increase in DMI would be approximately 3.4%. We rounded this to 3% for used in the program. Since the leafy hybrid in our study had an NDF digestibility increase that was 30% of the BMR hybrid relative to the conventional hybrid, we assumed the increase in intake would be proportional to that and assumed an increase in DMI of 1.0% relative to the conventional hybrid. For the mid group ration with a 26% corn silage inclusion rate, predicted increases in intake were estimated to be 5.25% (rounded to 5%) and 1.6% (rounded to 2%) for the BMR and leafy hybrid, respectively.

For each group, the model predicted potential milk production based on metabolizable energy (ME Milk), milk production based on metabolizable protein (MP Milk), daily weight change at a fixed milk production level, and metabolizable protein levels from bacteria. We also calculated cost/100 lbs of milk and income over feed costs. These were estimated at both the initial production level and at ME milk.

Our simulation did not consider any beneficial effects on herd health or reduced needs of amino acid supplementation that may result from improved NDF digestibility.

## **Results**

### **High Group Simulation**

The results of the CNCPS simulation indicated that when we switched from the conventional hybrid to the leafy hybrid that had slightly higher whole plant and NDF digestibility, there was only a small (0.7lb/hd/d) increase in ME milk predicted in the high group when DMI was not increased (Table 4). When we increased the ration DMI by 1% to reflect the higher NDF digestibility of the corn silage, then milk production increased by 1.9 lb/hd/d compared to the conventional. In a recent feeding trial contrasting a leafy and conventional hybrid Kuehn et al. (1999) did not find increased milk production or DMI even though the leafy hybrid had slightly higher whole plant digestibility and NDF digestibility. Likewise, (Ballard et al. 2001) did not find differences in milk production in a comparison between a conventional (Pioneer) and leafy (Mycogen) hybrid. In that case the conventional hybrid silage had 4-percentage units higher NDF digestibility and similar whole plant digestibility to the leafy hybrid. Thus, the increase in ME milk levels predicted by the CNCPS simulation associated with relatively small increases in NDF digestibility appear to be higher than those achieved in

the results of feeding trials.

When the BMR hybrid was substituted into the ration, the simulation predicted an increase in ME milk of 1.7 lbs/day at similar DMI levels and when the DMI was increased by 3%, ME milk increased 5.3 lb/d. This supports the concept that the largest source of improvement in milk production from BMR silages is from the improved DMI, not from the higher energy level of the silage. In the Ballard et al. (2001) trial, switching to a BMR hybrid compared to a conventional increased 3.5% FCM by 5.5 lbs/day. In that trial the BMR hybrid had higher whole plant digestibility and higher NDF digestibility than the conventional hybrid, similar to the values used in our simulation, but the corn silage inclusion rate in the ration was 31% compared to 17 % in our simulation. In the Oba and Allen (1999) study, the BMR hybrid had higher NDF digestibility and lower NDF than the conventional control hybrid. Both hybrids were fed at a 44.6% inclusion rate. In that trial, the BMR resulted in an increase of 3.5% FCM by 5.7 lbs/day. Dry matter intake increased by 8.9% with the BMR hybrid in that trial. Compared to the results of these trials, the 5.5 lb/d increase in milk predicted in our simulation with the BMR corn silage at 17% of the ration is higher.

The improvements in ME milk predicted by the model may be optimistic since they do not account for energy that may be diverted for body weight gain. Also, these predicted increases in milk production would be contingent on achieving the increases in DMI.

Milk production estimates based on available metabolizable protein (MP milk) indicated that for this ration MP was not limiting milk production. Increases in MP milk followed similar trends as ME milk. The model predicted higher microbial protein production from the leafy and BMR hybrids than the conventional hybrid and also more microbial protein production when DMI was increased.

Cost of production and income over feed costs were calculated for both the existing milk production levels and those possible with at the ME milk levels predicted by the model. The model indicated that if milk production were not increased, then the conventional hybrid would result in the lowest cost and highest income over feed costs. If milk production were increased at levels predicted by the model, then the cost/100 lbs of milk for this group would be lowest with the leafy hybrid. Income over feed costs was highest with the BMR hybrid with increased intake for this group.

The increase in milk production could more than offset the higher costs of production for the BMR silage given the assumptions used in the simulation. We calculated that a 1.3lb/d increase in production would be necessary to offset the cost of production with the BMR where there was no increase in intake. Where DMI intake was increased with the BMR hybrid a 1.9 lb/d increase in milk production would be necessary to offset the additional costs associated with the BMR hybrid. These estimates do not consider any possible adjustments to the ration that might be considered with the BMR hybrid.

Increases in the metabolizable protein from bacteria (MP from bacteria) with increasing fiber digestibility suggest that it may be possible to reduce bypass protein supplementation in these situations.

The economic advantage of the lower yielding BMR hybrid in this simulation might not be realized if the lower yield potential of this hybrid kept the farm from producing enough corn silage to meet its needs. This could contribute to more reliance on off farm feeds and a buildup of nutrients on the farm. For the farm used in this simulation where corn silage was less than 20% of the ration, this should not be a problem.

### **Mid Group Simulation**

The analysis for the mid group of cows showed that ME milk and MP milk levels. Similar trends occurred in this group as did in the High Group, but the increases in ME milk were slightly larger because corn silage was a larger component of the ration. ME milk increased 1.0 lbs/day with the leafy relative to the conventional and by 2.2 lbs milk with the BMR relative to the conventional. When intake was increased, ME milk increased 2.8 lb/d for the leafy and 6.9 lb/d for BMR hybrids relative to the conventional. According to Oba and Allen (1999) lower producing cows tend to show less response to BMR silage, since their DMI is less likely to be limited by ruminal fill but this did not appear to be the case in this simulation. The mid group animals averaged 200 days after calving compared to 90 days for the high group. Compared to responses in the literature, the increases in ME milk with the increased intake estimates appear somewhat optimistic in this group as well.

The economic analysis for this group showed similar results as for the high group. If milk yields remained constant, then the conventional hybrid had the lowest cost/100 lbs. milk and the greatest income over feed costs. If milk production would have increased to ME milk levels then the leafy hybrid would have had the lowest cost/100 lbs milk and the BMR hybrid would have had the highest income over feed costs. This resulted because of higher milk production on the BMR offset the lower cost/100 pounds of milk with the leafy hybrid. When intake was increased, the cost/100 pounds of milk was decreased for both hybrids and the income over feed costs was increased. The highest income over feed costs was produced with the BMR hybrid with the increased intake.

### **Milk2000 Analysis**

The potential milk production per ton and milk production per acre was evaluated using the Milk2000 spreadsheet recently developed at the University of Wisconsin (Shaver et al., 2000). This analysis showed that the milk/ton was highest for the BMR and lowest for the conventional hybrid. We then calculated the estimated differences in milk/ton based on the CNCPS simulations between the conventional and leafy and BMR hybrids. These were calculated with and without an increase in intake. The Milk2000 predicted differences in milk/ton were intermediate between those predicted with no increase in intake and those estimated with the 1 and 3% increases in intake.

The milk/acre values predicted by the model integrate the milk/ton and the yield of the hybrids. Often this is used as criteria for selection of the optimum hybrid. In this case the Milk2000 milk per acre estimates were similar for the conventional and leafy hybrids but the milk per acre for the BMR was substantially lower than the other two hybrids.

Using the milk/acre as a criterion for selection would result in a different conclusion than using the economic analysis in the CNCPS model. This illustrates the danger of using milk/acre as the sole criteria for hybrid selection.

### **Sensitivity Analysis**

To assess the sensitivity of the CNCPS 4.0 model to changes in the fiber digestibility in corn silage, we conducted several simulations using the conventional hybrid and varied the available fiber digestion rates (CHO:B2) using the values we obtained for the leafy and BMR hybrids. As in our original simulations, we also conducted simulations with increases in intake of 1 and 3% for the intermediate and high fiber digestion rates, respectively. The predicted values of ME milk for simulations with the conventional hybrid and also for the original hybrids are shown in Table 7. These data indicate that much of the variation in the results are due differences in variability of the fiber digestion rates rather than other characteristics of the hybrids.

### **Conclusions**

This simulation study suggests that high and medium producing groups of animals may respond to improved fiber and whole plant digestibility levels and that these responses could compensate for some reduced agronomic performance. The simulated milk production increases associated with higher fiber digestibility appeared to be slightly more than those predicted from feeding trials conducted under similar conditions. Our estimates of potential milk production were based on ME milk, and this may not account for energy used for other uses. Alternatively, the model may be more sensitive to small changes in NDF digestibility than the animals.

For lower producing herds or mid to low groups of animals, the production and economic responses to improved corn silage NDF digestibility were greater than those observed with the high producing group due to the higher corn silage inclusion rate in the ration.

The model predicted that the highest income over feed costs for both group would be with the most expensive, lowest yielding, BMR hybrid, provided the estimated milk production response occurred. For both groups the model suggested the conventional hybrid would be the most economical alternative if no milk response occurred.

The model confirmed some concepts reported in feeding trials. The largest milk responses from hybrids with higher digestibility and NDF digestibility appear to be due to the energy associated with increased DMI intake rather than the digestibility of the hybrids. This was consistent with the findings of Oba and Allen (1999).

The CNCPS model predicted similar milk/ton responses as the Milk2000 model. The Milk2000 model predictions of milk per acre were not representative of the economic rankings of the hybrids in CNCPS model. Thus interpretations using the milk/acre variable should be viewed with caution.

It is also important to note that individual conventional and leafy hybrids vary in digestibility, NDF digestibility and other characteristics as Lauer et al. (2000) and Thelen et al. (2000) have shown, our results should not be interpreted to be representative for all hybrids of each class. BMR hybrids often have the higher fiber digestibility relative to the other hybrids as we observed in this study.

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Table 1. Yield and composition of whole plant samples from different three corn hybrid types grown at three different locations in 2000.

Parameter	Conventional	Leafy	BMR
Yield (T/A)	20.1	19.1	15.5
DM	36.8	34.3	34.5
NDF	44.6	43.7	41.1
CP	7.3	7.4	7.1
Starch	34.6	35.7	34.3
WP digestibility*	73.0	73.3	76.1
Fiber digestibility*	43.2	45.3	50.9
Lignin (%NDF)	4.1	4.3	2.0
Sol. Prot.	17.8	18.9	22.7
ADI-CP (%CP)	2.88	2.07	3.15
NDI-CP (%CP)	17.6	24.1	20.6
Starch (% NSC)	86.1	84.8	78.9
CHO-B2 (%/hr)	3.65	4.68	5.19

\* based on 24 hr in vitro cellulase procedure

Table 2. Rations for the lactating cow groups.

Forage	High Group	Mid/Low Group
	% of DM	
Alfalfa/Grass Silage	30.23	37.03
Corn Silage	17.36	25.91
Cottonseed	4.79	5.12
Ground Corn	14.74	14.90
Citrus Pulp	5.63	0.00
Megalac	0.87	0.47
Molasses	4.09	2.20
Grass Hay	1.60	0.00
Protein supplement	20.70	14.38

Table 3. Nutrient composition of the simulated dairy rations for the three hybrids and two production groups.

Nutrient	High Group			Mid/Low Group		
	Conventional	Leafy	BMR	Conventional	Leafy	BMR
	% of DM					
NDF	31.9	31.8	31.3	35.5	35.3	34.6
NFC	40.6	40.9	41.4	39.5	39.8	40.7
CP	17.6	17.6	17.6	16.5	16.5	16.5
NE <sub>L</sub>	0.75	0.75	0.75	0.74	0.74	0.74
% Forage	49.2	49.2	49.2	62.9	62.9	62.9

Table 4. Animal performance, feed costs, income over feed costs and metabolizable protein from rumen bacteria simulated with three corn silage hybrid types using CNCPS 4.0 for the high group of animals in the Miner Institute dairy herd that were averaging 101 lbs of milk/cow/day.

Hybrid	DMI lbs/day	ME Milk lbs/day	MP Milk lbs/day	No Increase in Milk Production			Milk Production Increased to ME milk		MP from Bacteria g/day
				Daily Wt Change @ 101lb/d lbs/d	Cost/100 lbs milk @ 101lb/d \$/100lbs	Income over feed costs @ 101lb/d \$/hd	Cost/100 lbs milk @ME Milk \$/100 lbs	Income over feed costs @ ME Milk \$/hd	
Conventional	59.9	101.9	111.4	0.1	4.03	9.32	3.99	9.43	1635
Leafy	59.9	102.6	113.5	0.2	4.05	9.30	3.98	9.50	1654
Leafy*	60.5	103.8	114.8	0.4	4.09	9.26	3.97	9.62	1667
BMR	59.9	103.6	114.1	0.4	4.13	9.21	4.02	9.56	1670
BMR**	61.7	107.2	117.9	0.9	4.25	9.09	4.01	9.91	1708

\*DMI increased by 1% due to higher dNDF for leafy

\*\*DMI increased by 3% due to higher dNDF for BMR

Table 5. Animal performance, feed costs, income over feed costs and metabolizable protein from rumen bacteria simulated with three corn silage hybrid types using CNCPS 4.0 for the mid group of animals in the Miner Institute dairy herd that were averaging 65 lbs of milk/cow/day.

Hybrid	DMI lbs/day	ME Milk lbs/day	MP Milk lbs/day	No Increase in Milk Production			Milk Production Increased to ME milk		MP from Bacteria g/day
				Daily Wt Change @65lb/d lbs/d	Cost/100 lbs milk @65lb/d \$/100lbs	Income over feed costs @65lb/d \$/hd	Cost/100 lbs milk @ME Milk \$/100 lbs	Income over feed costs @ ME Milk	
Conventional	46.5	69.2	70.9	0.5	4.07	5.97	3.82	6.53	1270
Leafy	46.5	70.2	73.1	0.7	4.10	5.95	3.80	6.64	1293
Leafy*	47.4	72.0	74.8	0.9	4.18	5.90	3.77	6.82	1313
BMR	46.5	71.4	74.2	0.8	4.25	5.85	3.87	6.70	1313
BMR**	48.8	76.1	78.3	1.4	4.46	5.71	3.81	7.18	1365

\*DMI increased by 2% due to higher dNDF for leafy

\*\*DMI increased by 5% due to higher dNDF for BMR

Table 6. Milk per ton and milk per acre for the three hybrids estimated using the Milk 2000v.4 equation.

Hybrid	Milk per Acre lbs/acre	Milk per Ton lbs/ton	Estimated Milk/ton	Estimated Milk/ton	Estimated Milk/ton
			Diff. M2000 lbs/ton	Diff. CNCPS lbs/ton	Diff. CNCPS* lbs/ton
Conventional	20227	2877	-	-	
Leafy	20298	3030	153	135	186
BMR	17519	3244	367	325	414

\* increased intake for leafy (1%) and BMR (3%)

Table 7. Animal performance simulated with a single hybrid varying in fiber digestion rates (CHO:B2) compared to three corn silage hybrids using CNCPS 4.0 for the high group of animals in the Miner Institute dairy herd that were averaging 101 lbs of milk/cow/day.

Hybrid/CHO:B2 dig. rate(%/hr)	DMI lbs/day	ME Milk lbs/day	MP Milk lbs/day	Daily Wt Change @ 101lb/d	Hybrid	DMI lbs/day	ME Milk lbs/day	MP Milk lbs/day	Daily Wt Change @ 101lb/d
				lbs/d					lbs/d
Conv. 3.65	59.9	101.9	111.4	0.1	Conventional	59.9	101.9	111.4	0.1
Conv/ 4.68	59.9	102.6	112.7	0.2	Leafy	59.9	102.6	113.5	0.2
Conv/4.68*	60.5	103.8	113.9	0.4	Leafy*	60.5	103.8	114.8	0.4
Conv/5.19	59.9	102.9	113.2	0.3	BMR	59.9	103.6	114.1	0.4
Conv/5.19**	61.7	106.4	116.9	0.8	BMR**	61.7	107.2	117.9	0.9

\*DMI increased by 1% due to higher dNDF

\*\*DMI increased by 3% due to higher dNDF

## Appendix

Yield and forage quality of five corn hybrids grown at three locations in Pennsylvania in 2000.

Table A1. Performance of five hybrids for silage production in Crawford County, PA in 2000.

Hybrid	Yield	DM	ADF	CP	Ash	Sol Sugar	Starch	NDF	WPDig	FiberDig	Population
	T/A	%	%	%	%	%	%	%	%	%	Plants/acre
Pioneer 38T27	19.9	31.3	20.7	6.7	2.3	8.5	33.2	38.9	73.2	42.2	23900
Cargill F277	16.0	29.4	19.8	6.9	1.9	9.7	29.7	40.1	75.4	50.0	25007
Novartis NX3018	17.0	27.0	16.0	7.7	1.9	11.8	28.6	36.4	78.6	47.1	23227
Mycogen 2404 (TMF)	19.0	29.2	22.2	7.0	2.6	10.0	27.3	42.1	71.8	44.8	22125
Mycogen 2424	18.4	31.1	18.8	6.9	2.1	10.5	32.9	37.1	75.7	45.8	25112
LSD (0.05)	NS	2.4	4.0	0.6	NS	2.0	NS	3.8	NS	2.5	NS

Table A2. Performance of five hybrids for silage production in Lycoming County, PA in 2000.

Hybrid	Yield	DM	ADF	CP	Ash	Sol Sugar	Starch	NDF	WPDig	FiberDig	Population
	T/A	%	%	%	%	%	%	%	%	%	Plants/acre
Pioneer 38T27	19.7	41.1	21.6	6.4	2.0	6.7	32.8	42.4	72.5	44.2	25365
Cargill F277	17.4	39.8	19.3	6.5	1.8	6.6	34.5	41.3	76.6	51.4	25221
Novartis NX3018	16.2	36.1	17.9	7.5	2.2	8.6	33.1	37.5	76.2	47.3	21368
Mycogen 2404 (TMF)	19.4	39.3	20.9	6.7	2.2	6.3	33.4	41.5	73.3	44.7	25776
Mycogen 2424	18.0	36.5	21.0	6.4	2.0	9.0	30.6	42.1	74.3	47.3	25132
LSD (0.05)	NS	3.1	NS	0.8	NS	1.9	NS	NS	2.6	2.6	2143

Table A3. Performance of five hybrids for silage production in Centre County, PA in 2000.

Hybrid	Yield	DM	ADF	CP	Ash	Sol Sugar	Starch	NDF	WPDig	FiberDig	Population
	T/A	%	%	%	%	%	%	%	%	%	Plants/acre
Pioneer 38T27	21.3	38.3	20.7	7.2	2.5	4.8	34.4	40.0	72.9	43.2	27947
Cargill F277	13.2	38.2	18.8	7.7	2.1	5.6	34.0	40.2	77.0	51.6	27129
Novartis NX3018	17.0	32.2	19.8	8.0	2.3	7.7	30.0	41.1	74.4	47.5	25692
Mycogen 2404 (TMF)	19.0	34.6	19.8	7.3	2.4	9.0	31.1	39.8	74.9	46.6	25932
Mycogen 2424	20.0	35.8	19.6	6.6	1.8	7.5	35.0	39.7	75.0	44.8	26328
LSD (0.05)	3.0	3.1	NS	0.7	NS	3.2	NS	NS	NS	2.7	NS

Table A4. Performance of five hybrids for silage production averaged over three locations in PA in 2000.

Hybrid	Yield	DM	ADF	CP	Ash	Sol Sugar	Starch	NDF	WPDig	FiberDig	Population
	T/A	%	%	%	%	%	%	%	%	%	Plants/acre
Pioneer 38T27	20.1	36.8	20.9	6.7	2.2	6.9	33.5	40.5	73.0	43.2	25737
Cargill F277	15.5	35.8	19.4	7.0	1.9	7.3	32.4	40.7	76.1	50.9	25785
Novartis NX3018	16.7	31.8	17.9	7.7	2.2	9.4	30.6	38.3	76.4	47.3	23429
Mycogen 2404 (TMF)	19.1	34.3	21.0	7.0	2.4	8.4	30.6	41.1	73.3	45.3	24611
Mycogen 2424	18.8	34.5	19.9	6.6	2.0	9.0	32.8	39.7	75.0	46.0	25524
LSD (0.05)	2.0	2.3	NS	0.4	NS	1.5	NS	NS	NS	1.3	NS
Pvalue	0.01	0.01	0.10	0.003	0.09	0.05	0.3	0.4	0.07	0.001	0.15

Table A1. Performance of five hybrids for silage production in Crawford County, PA in 2000.

Hybrid	Yield	DM	ADF	CP	Ash	Sol Sugar	Starch	NDF	WPDig	FiberDig	Population
	T/A	%	%	%	%	%	%	%	%	%	Plants/acre
Pioneer 38T27	19.9	31.3	20.7	6.7	2.3	8.5	33.2	38.9	73.2	42.2	23900
Cargill F277	16.0	29.4	19.8	6.9	1.9	9.7	29.7	40.1	75.4	50.0	25007
Novartis NX3018	17.0	27.0	16.0	7.7	1.9	11.8	28.6	36.4	78.6	47.1	23227
Mycogen 2404 (TMF)	19.0	29.2	22.2	7.0	2.6	10.0	27.3	42.1	71.8	44.8	22125
Mycogen 2424	18.4	31.1	18.8	6.9	2.1	10.5	32.9	37.1	75.7	45.8	25112
LSD (0.05)	NS	2.4	4.0	0.6	NS	2.0	NS	3.8	NS	2.5	NS

Table A2. Performance of five hybrids for silage production in Lycoming County, PA in 2000.

Hybrid	Yield	DM	ADF	CP	Ash	Sol Sugar	Starch	NDF	WPDig	FiberDig	Population
	T/A	%	%	%	%	%	%	%	%	%	Plants/acre
Pioneer 38T27	19.7	41.1	21.6	6.4	2.0	6.7	32.8	42.4	72.5	44.2	25365
Cargill F277	17.4	39.8	19.3	6.5	1.8	6.6	34.5	41.3	76.6	51.4	25221
Novartis NX3018	16.2	36.1	17.9	7.5	2.2	8.6	33.1	37.5	76.2	47.3	21368
Mycogen 2404 (TMF)	19.4	39.3	20.9	6.7	2.2	6.3	33.4	41.5	73.3	44.7	25776
Mycogen 2424	18.0	36.5	21.0	6.4	2.0	9.0	30.6	42.1	74.3	47.3	25132
LSD (0.05)	NS	3.1	NS	0.8	NS	1.9	NS	NS	2.6	2.6	2143

Table A3. Performance of five hybrids for silage production in Centre County, PA in 2000.

Hybrid	Yield	DM	ADF	CP	Ash	Sol Sugar	Starch	NDF	WPDig	FiberDig	Population
	T/A	%	%	%	%	%	%	%	%	%	Plants/acre
Pioneer 38T27	21.3	38.3	20.7	7.2	2.5	4.8	34.4	40.0	72.9	43.2	27947
Cargill F277	13.2	38.2	18.8	7.7	2.1	5.6	34.0	40.2	77.0	51.6	27129
Novartis NX3018	17.0	32.2	19.8	8.0	2.3	7.7	30.0	41.1	74.4	47.5	25692
Mycogen 2404 (TMF)	19.0	34.6	19.8	7.3	2.4	9.0	31.1	39.8	74.9	46.6	25932
Mycogen 2424	20.0	35.8	19.6	6.6	1.8	7.5	35.0	39.7	75.0	44.8	26328
LSD (0.05)	3.0	3.1	NS	0.7	NS	3.2	NS	NS	NS	2.7	NS

Table A4. Performance of five hybrids for silage production averaged over three locations in PA in 2000.

Hybrid	Yield	DM	ADF	CP	Ash	Sol Sugar	Starch	NDF	WPDig	FiberDig	Population
	T/A	%	%	%	%	%	%	%	%	%	Plants/acre
Pioneer 38T27	20.1	36.8	20.9	6.7	2.2	6.9	33.5	40.5	73.0	43.2	25737
Cargill F277	15.5	35.8	19.4	7.0	1.9	7.3	32.4	40.7	76.1	50.9	25785
Novartis NX3018	16.7	31.8	17.9	7.7	2.2	9.4	30.6	38.3	76.4	47.3	23429
Mycogen 2404 (TMF)	19.1	34.3	21.0	7.0	2.4	8.4	30.6	41.1	73.3	45.3	24611
Mycogen 2424	18.8	34.5	19.9	6.6	2.0	9.0	32.8	39.7	75.0	46.0	25524
LSD (0.05)	2.0	2.3	NS	0.4	NS	1.5	NS	NS	NS	1.3	NS
Pvalue	0.01	0.01	0.10	0.003	0.09	0.05	0.3	0.4	0.07	0.001	0.15