

# 1998 Kellogg Biological Station Farm Report

## Michigan State University W.K. Kellogg Biological Station

### ***Introduction***

Bernard D. Knezek, Associate Director Kellogg Biological Station

Each year since the first Kellogg Farm Annual Report (1992), I have written the introduction. The first report (1992) gave an overview of the new Dairy Farm's first 10 years. While reviewing the 1992 edition, I found many comments that bear repeating.

Kellogg Biological Station's agricultural programs are coordinated with the station's ecology and evolutionary biology activities: they do not function independently. Each program relates to the others, as well as to the community and the natural ecosystems contained within the surrounding Gull Lake watershed.

- Farming Systems Center: Researchers here conduct studies aimed at producing high-quality human and animal food plants using cropping systems that are sustainable, profitable, socially acceptable and environmentally sound.
- Long-Term Ecological Research Project: This project includes ongoing investigations of the interaction between crops, weeds, soil components and tillage practices. Studies range from examinations of single-celled organisms to entire agricultural systems, all looking to develop cropping systems that help farmers lessen their dependence on manufactured chemical and fertilizer inputs. It is the only agriculturally related node in the National Science Foundation's multi-continent network
- Living Field Laboratory: This set of research trials was designed to identify and quantify the effects of soil biology processes that help producers maintain high nutrient availability with reduced nutrient loss.
- Kellogg Dairy Farm: Created to facilitate whole-herd management and nutrition research and education, the Farm includes a visitors' center, a herd of registered Holsteins, feed and equipment storage facilities and crop acreage. Its goals are to understand the relationships and balances inherent within cropping and livestock units and develop sustainable whole-farm systems.

Through the years we have kept the Kellogg Farm's focus on sustainability and whole-farm systems for dairy farmers. We have added forage and rotational grazing studies and cover crop research. We have been looking at restructuring our priorities and our mission during the past year and I want to recognize the staff's teamwork and dedication while changes were, and are, contemplated.

I extend my thanks to those who contributed to this report and to those that compiled and prepared it. The continued support of Kellogg Farm by the Michigan Agricultural Experiment Station, the Michigan State University Extension, the Michigan State University Department of Land Management, the Kellogg Trust Fund, and the Michigan State University general fund is gratefully acknowledged.

Comments or questions about the Kellogg Farm 1998 Annual Report should be addressed to:

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## Long-Term Ecological Research In Field-Crop Agriculture

Mark A. Halvorson, LTER Agronomic Manager

W. K. Kellogg Biological Station and Michigan State University

### Agronomic Summary Report 1998 - Wheat

Long-Term Ecological Research (LTER) Project Agronomic information is available via an updated LTER web page and in addition, many other agronomic related web sites are included in this section of the Kellogg Farm Report. In past years, space limitations have truncated the LTER Kellogg Agronomic Report, however hyper-links have added more of LTER / Research/Agronomic information and are available for viewing. Review the site description for the KBS-LTER at <http://lter.kbs.msu.edu>.

Other links can be accessed through the LTER Home Page such as Affiliated WWW Sites, the LTER Network, the National Science Foundation, the Center for Microbial Ecology (MSU) , KBS, MSU Extension, and Entomology Spatial Analysis Lab.

### 1998 Climatic Conditions

Climatic conditions for any date or combinations of dates at the Kellogg Biological Station in 1998 can be viewed on-line. Garrett Ponciroli, using ACCESS, has developed a weather data set allowing persons to run data queries about specific LTER weather data. One can access and generate any weather data from 1989 to the current conditions.

Drought conditions caused highly variable plant growth across small spatial gradients on the LTER site again in 1998. Much of the spatial variability for wheat yield in 1998 was an influence of limited precipitation and dry soil conditions on plant growth early in the growing season.

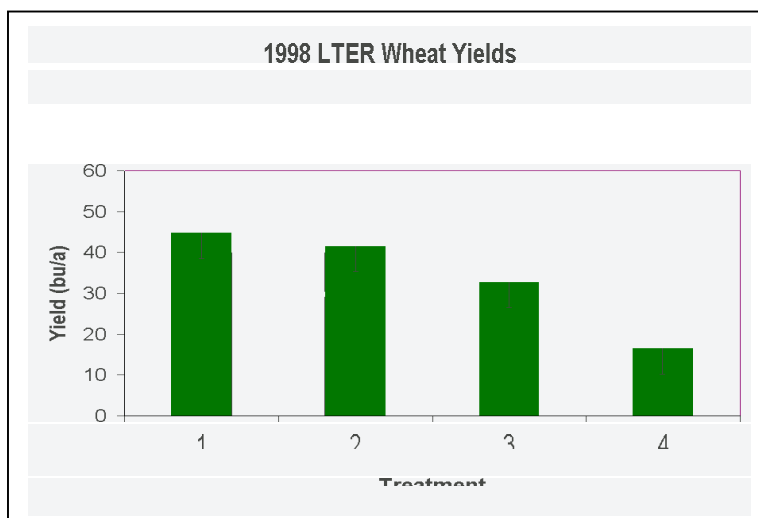
### Agronomic Cropping Systems / Corn-Soybean-Wheat Rotation

LTER in row-crop agriculture at KBS completed its tenth cropping season in 1998. Field-crop agronomic research includes four annual cropping systems (TRT 1-4) and alfalfa in the perennial cropping system (TRT 6). The annual cropping systems are in a corn, soybean, and wheat rotation. Winter wheat was planted the fall of 1998 after soybeans had been harvested and the yield results of the wheat crop are included in this report.

Four annual cropping systems included, (treatment one, conventional till (CT)), (treatment two, no till (NT)), (treatment three, low chemical input (LI)) and (treatment four, zero chemical input (ZI)) treatments. Each treatment is replicated six times and was planted to wheat in the fall of 1997.

Visual differences on a spatial scale could be detected later in the growing season again in 1998. These spatial differences are closely correlated to the effects of spring drought on final grain yield. The soil's ability to retain soil moisture and make it available to the plants under different cropping system regimes in a dryer-than-normal year should again increased the scope of this experiment.

### Wheat Yield



The LTER variant table explaining the parameters for reporting agronomic crop research and wheat is now online. The 1998 wheat yields for grain were calculated and are also available. Actual grain yield is calculated for the east 165 feet in each plot. Wheat grain was measured for moisture at harvest. Yields are corrected to 13 percent moisture and recorded on a dry matter basis for that crop as bushels per acre.

One can view General Geographical Information Systems (GIS) information or an index of geo-referenced LTER materials. There is also a World Wide Web site for frequently asked questions FAQs) about Global Positioning Systems (GPS) and a general overview for Site-Specific (precision agriculture) farming information. Variable rate applications of crop inputs on the LTER site have not been done in the past and probably will not be done in the near future on the LTER due to agronomic research constraints. Examples of variable rate inputs can be adjusted on the go to match needs for ideal plant growth and include items such as fertilizers, pesticides and crop seeding rates or varieties.

The LTER began collecting GIS data during the 1996 corn harvest. In 1998, site specific yield monitoring data collection of crop yields went well throughout most of the wheat harvest season. Yield maps, elevation and grain moisture at harvest maps have been developed to correlate the spatial differences for each replicate by treatment and the relationships for influences on grain yield. Imagery and Near Infrared Photography data are also being explored and will likely be included in the final analysis and field mapping of the LTER Main Site by year.

The Cray air finger reel that was added to the header of our JD 4425 combine in 1997 worked well for wheat harvest also in 1998. The reel was mounted on the combine header just prior to the 1997 soybean harvest and allowed us to collect less variable grain yield data in 1998 as it did for soybeans in 1997. The air-reel helped harvesting the wheat by forcing the grain heads into the combine header with forced air. The final result was a uniform grain flow and a uniform GIS data accumulation generated at the impact sensors and logged more even data to PCMCIA cards in the yield monitor. During the 1998 wheat season, most of the LTER site (TRT 1-4) was again logged in one-second intervals for grain yield, percent moisture at harvest, elevation and geo-referenced all these data points with location (sub-meter) information. Location data is collected in decimal degrees. Data is exported out of Ag Leaders Mapping Program and put into the ESRI Spatial Analyst to change coordinates to UTM. Maps are then drawn with the SW corner plots as the 0-meter, 0-meter location and each point N and E of the SW post is given as meters North and meters East. Positioning data was gathered and transmitted via the LTER's base station using signals from earth orbiting satellites.

The Ag Navigator GPS guidance system was used in 1998 to generate geo-referenced data points and linked that data with the yield monitoring data with sub-meter accuracy. For example, as was reported during the 1998 LTER All-Investigator Meeting, 1996, 1997 and 1998, high heterogeneity of corn, soybean and wheat yields across small spatial distances in Treatment 3 (low chemical input plot) in Replicate 3 would have been difficult to detect without the aid of this system. Geo-referenced data maps and semi-variograms for annual cropped treatments across the whole LTER will soon be available for viewing on the World Wide Web. The 1998 yield data have been mapped for an initial viewing and have been analyzed for semi-variance tendencies and other statistical evaluations, cleaned up and remapped. Final yield maps and analysis information are available from Dr. G. Philip Robertson. The perennial cropping system alfalfa may also be added to the future precision farming data collection process.

## ***Effect of Cropping on Soil Phosphorus***

Samira H. Daroub<sup>1</sup>, Boyd G. Ellis and G.P. Robertson

Crop and Soil Science and W. K. Kellogg Biological Station

### **Justification and Objectives**

Reducing phosphorus (P) fertilizer inputs in agricultural production in the US has become essential to reduce P loads into surface waters. Most agricultural soils in the US have adequate to excess supply of P due to the excessive use of P fertilizers in the past. Reducing reliance on external P inputs makes it critical to understand P dynamics under management systems that rely more on organic phosphorus (Po) and less on inorganic phosphorus (Pi). Two questions need to be answered: 1) Would Po in the soil be sufficient for plant demand in the future when the levels of Pi decrease, and 2) What are the management practices that could help to increase Po content under agriculture production. In this research, we attempt to address the second question imposed while the answer to the first question will still take few years to answer while the levels of Pi decrease in soils. The long term ecological research (LTER) site at Kellogg Biological Station (KBS) has not received any P fertilizers since its establishment in 1988, however there is still no sign that the lack of application of P is affecting yields. The objectives of this work were to assess the impact on Pi and Po of:

1. Conventional long-term management row crop agriculture.
2. Alternative management systems like no-tillage and the use of winter cover crops as well as perennial cropping systems that had been imposed for 7 years.

### **Procedures:**

Soils were sampled from all eight treatments in the LTER main site as well as from the Deciduous forested site in July 1995 (Table 1). All of the replications were sampled at the 0-25 cm depth. The soils were air dried and ground to pass a 0.25 mm (60 mesh) sieve and stored at room temperature. Soils were extracted for P using the fractionation procedure developed by Hedley et al. 1982. In short, 0.5 g dry soil was weighed into a 50 ml centrifuge tube, 30 ml of water added, and 0.4 g Dowex 1x850 anion exchangeable resin in the HCO<sub>3</sub> form in a nylon mesh bag was added and the tube shaken for 16 hours. Resin P was eluted from the bag with 0.5 N HCl. The residual soil was then extracted sequentially with 0.5 N NaHCO<sub>3</sub>, 0.1 N NaOH, 0.1 N NaOH with sonication, and 1 N HCl. Each of these extractions was comprised of 16 hours of shaking, then centrifuging the tube at 10,000 RPM for 10 minutes. The clear solution was then decanted and frozen before analysis. Finally the soil was digested with sulfuric acid and hydrogen peroxide for determination of residual P. Inorganic P was analyzed in all fractions by the method of Murphy and Riley (1962) using an automated flow injection analyzer after adjusting the pH of the extracted solutions. Total P was measured in the NaHCO<sub>3</sub>, NaOH, and NaOH with sonication extracts after digesting the samples with sulfuric acid and ammonium persulfate on a hot plate (US EPA, 1978) and analyzed with the same method as above. Organic P was obtained as the difference between total and inorganic P in these three fractions. Resin extractable Pi is considered to be the most biologically available to the plant (Amer et al., 1955; Sibbesen, 1977). Sodium bicarbonate at pH 8.5 extracts labile organic compounds like ribonucleic acid and glycerophosphate (Bowman and Cole, 1978). The NaHCO<sub>3</sub> extractable Pi and Po fractions constitute labile pools and are readily available to plants. The NaOH extractable Pi and Po fractions are moderately labile P and are P chemisorbed on Fe and Al oxides (Ryden et al. 1977). Sonication with NaOH extraction allows the release of physically protected Pi and Po (Hedley et al. 1982). Calcium phosphates are mainly extracted with HCl. Residue P may contain both inorganic and organic P that is very resistant to decomposition. Although this fractionation does not define the components of each group, it will relate to the pools of rapid and slow cycling organic matter and allow the detection of changes in P cycling within an intermediate time frame. ANOVA was run on treatments 1 through 7 for all fractions using PROC GLM in SAS.

## Summary Results and Discussion:

### *Long-term management impact:*

Prior to 1988 when the LTER treatments were imposed, the cropping system was corn/ soybean /wheat conventionally tilled with standard inputs of fertilizer and pesticides for the last 50 years. Therefore, we evaluated the long-term impact of conventional agriculture on P by comparing the conventionally tilled treatment with standard levels of agrochemical inputs (CT) with the Deciduous forest (DF). Differences between means were evaluated using PROC TTEST in SAS since the DF treatment is not part of the block design of the main LTER site. Significant differences were found between the means of all the fractions extracted except resin Pi and Po extracted by NaOH after sonication. Conventional tillage resulted in decrease of the organic P by 33.1% and an increase in the inorganic P by 15.8% and residual P by 17.3% compared to the DF. The differences in organic P were the greatest in the NaOH fraction. The increase in Pi under CT is due to the application of Pi fertilizer over the many years of cropping as well as to the mineralization of Po due to cultivation. Increase in P in the residual fraction in the CT treatment is an indication that a greater percentage of P is becoming more stable and therefore less available to plants on for a intermediate time frame under conventional systems.

### *Effect of cropping systems imposed for 7 years:*

There were no significant differences in P fractions when the annual cropping systems were compared ( treatments 1 through 4). The adoption of no-tillage and the use of winter cover crops for 7 years did not significantly increase Po when compared to CT, although some trends of increased Po were apparent. Organic P extracted by NaOH was 3.4% higher (from 11.4 to 14.8%) in the zero-input (winter cover crop) compared to the CT treatment, however this increase was not significant. Significant differences were observed in Po in the NaOH fraction, sum Po and the residual fraction in the alfalfa when compared to the CT treatment (Table 2). The increase in Po under alfalfa is attributed to the turnover of the extensive root system that the plants have. These soils were sampled in July during the growing season, when Po is expected to be high due to root death. Organic P is probably lower in early spring after significant mineralization have occurred. It is obvious though, that alfalfa cropping is transforming the Pi in the soil into organic P through assimilation of P in the roots and then root death.

### **Impact of Findings:**

This study assessed the impact of long term conventional row crop agriculture on soil P in KBS soils. It also determined the effect of alternative management systems imposed for 7 years on P in the LTER soils. The knowledge of the change in the chemical composition of P is important to maintain soil productivity under new and alternative management systems.

Table 1. Description of the cropping systems at the KBS LTER site

<b>Tmt</b>	<b>Abbreviation</b>	<b>Description</b>
1	CT Corn-Soybean-Wheat	standard level of agrochemical inputs; moldboard plowed
2	NT Corn-Soybean-Wheat	standard level of agrochemical inputs, No-till management
3	Low-input Corn-Soybean-Wheat	chemical inputs only to control outbreak pests; moldboard plowed; Winter leguminous cover crop.
4	Zero-input Corn-Soybean-Wheat	no chemical inputs at any time; moldboard plowed; Winter leguminous cover crop
5	Poplar	Poplar trees planted on a 6-7 year rotation cycle
6	Alfalfa	Continuous alfalfa
7	Native tilled	Native successional community; abandoned after spring plowing in 1989
8	Native never-tilled	Native successional community; Never plowed
DF	Forest	Native deciduous forest; old growth

Table 2. NaOH extractable Po, sum Po and residual P in two selected treatments (in percent of total P extracted).

Treatment	NaOH Po	Sum Po	Residual P
CT	11.4a	15.8a	36.5a
alfalfa	22.1b	26.8b	27.3b

Columns followed by different letters are significant at the 0.05 level.

#### Presentations of Research:

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**Research Projects Of The C. S. Mott Foundation Chair Of Sustainable Agriculture**  
 Richard Harwood, Jeff Smeenk, Jose Sanchez, Ann-Marie Ezanno, Tom Willson, and Elaine Parker  
 Michigan State University

**Overall Justification and Objectives:**

It is hypothesized that crop rotation, cover crop, and organic inputs can be combined for managing key soil biological processes to achieve higher crop yields, greater nutrient use efficiency, and less loss of nutrients to the environment. These research projects were designed to document efficiencies and key soil biological processes in corn, soybean, and wheat rotations using cover crop combinations.

**1998 Crop Yields at The Living Field Laboratory**

Procedures:

The Living Field Laboratory, the main field research project of the C.S. Mott Chair of Sustainable Agriculture, was in its sixth year in a four-year corn-corn-soybean-wheat rotation scheme. Each crop is grown each year. The experimental design is a split block within a split plot with four replications.

The treatments are as follows:

Management	Nutrient Source	Weed Control	Cover Crops
Organic (Org.)	KBS Compost	Cultivation only	Yes
Integrated Compost (I-C)	KBS Compost	Banded Herb. + Cultiv.	Yes
Integrated Fertilizer (I-F)	Fertilizer	Banded Herb. + Cultiv.	Yes
Conventional (Conv.)	Fertilizer	Broadcast Herbicide	No

	Cover Crops				No Cover Crops			Conv.
	Org.	1-C	1-F		Org.	1-C	1-F	
Soybeans	29	38	38		29	38	36	36
Wheat	33	27	49		31	30	47	48
1st yr Corn	123	106	107		111	111	119	100
2nd yr corn	95	85	114		89	86	108	89
6th yr corn	86	87	100		85	71	80	92

**Discussion on crop yields:**

*Soybeans:*

This was the first year that glyphosate tolerant soybeans were grown in the experiment. They were quite successful, even in the organic plots that didn't receive any herbicide. There was significantly less deer damage than in previous years. Combining cultivation with banded glyphosate resulted in very low herbicide rates with fairly low weed pressure.

*Wheat:*

The fertilized wheat continued to outperform the composted wheat. The red clover cover crop didn't significantly influence wheat yields for any of the treatments.

*Corn:*

The late summer dry spell reduced yields. There was adequate moisture in the first part of the season for good vegetative growth but the grain yield was lower than normal. Although 1st-year corn did not perform as well this year as it has in previous years, it still outperformed 2nd-year and continuous corn under most treatments. There was little difference in management operations between the organic 1st-year corn and the Integrated Compost 1st-year corn. Early season cultivation was very successful and banded herbicides were not needed. One possible explanation for the lower than expected yields of

Integrated compost 1st-year corn was that only half of the plot was harvested and thus the loss of a few ears prior to harvest would have made a big difference in yield per acre.

### ***Management of nitrogen mineralization***

Jose E. Sanchez, Richard Harwood, Jeff Smeenk, Tom Wilson, Ann Marie Ezanno, Elaine Parker, Greg Parker, Eldor Paul

The development of a sustainable agricultural system requires efficient soil nitrogen (N) management. For that reason we need to know the amount of N supplied to a growing crop from the mineralization of soil organic matter. Accurate estimate of N mineralization will avoid excess applications of nitrogen fertilizer and minimize possible groundwater contamination.

This project is being developed in the long-term cropping systems experiment of the Living Field Laboratory. A rotation of corn-corn-soybean-wheat is used in combination with cover crops to determine the optimum level of crop diversity that can be transferred to farmer fields. The LFL is a link between the basic ecological principles that are the foundation of sustainable agriculture systems and their agronomic application.

Part I of this investigation will establish a statistical model to describe the change in soil nitrate levels during the growing season and the differing pulses in nitrate concentrations over time in the rotation. Data from 1993-99 in the corn-corn-soybean-wheat rotation and continuous corn cropping systems is being used to develop a mathematical model of this pattern.

In part II, a study of soil N mineralization management is being developed. Soil nitrogen mineralization under field conditions was measured and used to estimate the N supplying capacity of the soil and its ability to mineralize added substrates (compost, red clover, or both). Long-term laboratory incubations were initiated in 1998 using soil from the first year corn with compost and cover crop plots, and continuous corn with commercial fertilizer without cover crops. To measure N mineralization under field conditions, microplots were implemented in the same plots used for the laboratory incubation. Field and laboratory experiments will be repeated in 1999.

Previous data indicate that soil from 1st year corn in the long-term rotation experiment shows higher net nitrate levels compared to soybean or wheat-red clover. Part III will look at the possible effect of corn roots on stimulating soil N mineralization. A field experiment using confining rings was implemented to determine this possible effect. This experiment will be repeated during the 1999-growing season.

### ***Effect of cultivation and cover-crop on yield of Roundup Ready® soybean***

Jose E. Sanchez, Greg Parker, Richard Harwood, Jeff Smeenk

The main goal of this project is to determine the impact of cultivation and cover-crop on grain yield of Roundup Ready® soybeans.

This project is being developed at the Kellogg Farm. This study was designed to minimize the use of Roundup® herbicide on Roundup Ready® soybean. It would reduce the chance to develop Roundup® resistance, and minimize any negative environmental impact due to excessive chemical application.

One application of Roundup® is followed by cultivation for later weed control. Cultivation was performed when the soybean canopy was 10 and 20 inches for the early and late cultivation treatment respectively.

Cultivation allows us to interseed a legume cover-crop in soybean, which will provide winter cover to the soil, and nitrogen credit for the next growing crop.

### ***Using Roundup Ready® soybean as cover-crop after wheat***

Jose E. Sanchez, Michel Cavigelli, Greg Parker, Richard Harwood, Jeff Smeenk

We are investigating the possible benefits of using Roundup Ready® soybeans as a cover-crop after wheat. It would serve as snow catching, and soil cover during the winter, and provide available nitrogen to the next crop. This project is being developed at the Kellogg Farm. Roundup Ready® soybeans were

drilled right after wheat harvest, and the application of Roundup® herbicide was performed in two different time periods for weed control. The field is undergoing observation this winter and the effect on next crop will be measured.

### ***The impact and significance of Nitrification Potentials in sustainable agriculture***

A.F. Ezanno, R.R. Harwood, and E.A. Paul

#### **Justification and Objectives:**

Sustainable management practices have caused nitrification potentials on the LFL to decrease. The use of nitrification inhibitors to reduce nitrate leaching is a common agricultural practice. Decreasing nitrification, the conversion of  $\text{NH}_4$  to  $\text{NO}_3$ , keeps plant available N in a form less likely to leach. Nitrogen that does not leach is available for plant uptake. Row crops are able to take up either form of N,  $\text{NH}_4$  or  $\text{NO}_3$ . We intend to measure the quantitative effect of several sustainable management practices in lowering nitrification rates. Does N management, N fertilizer vs. compost, effect nitrification? Does the cropping system, cover crops and/or crop rotations effect nitrification rates? Once nitrification rates are placed on a field basis, their impact on nitrate leaching will be assessed.

#### **Summary of Results:**

Plant available N on the LFL is affected by: nitrogen source; crop rotations; cover crops; and management effects. Nitrification rates are controlled by the amount of plant available N present. Any management practice that affects the amount of available N will have an impact on nitrification potentials. The nitrification potential is the maximum amount of N in the form of ammonia that can be converted to nitrate on a given date. We compared nitrification rates from laboratory experiments to those of field estimates. This allowed us to assess the impact of management and cropping systems on nitrification potentials.

Nitrification potentials compared across management system and date indicate that compost use in place of N fertilizer significantly decreased nitrification rates. Nitrification potentials in compost treatments were approximately 25% lower than those of fertilizer treatments. The quantity of N, the form of N, and the timing of N release effected nitrification potentials. The quantity of available N on compost plots was lower than fertilizer treatments. Measurements of the average annual inorganic N contribution from compost were between 40 B 53  $\text{kg N ha}^{-1}$  (Willson, et al., 1999). Fertilizer plots received 179  $\text{kg N ha}^{-1}$ . The  $\text{kg N ha}^{-1}\text{yr}^{-1}$  in crop residues tends to be lower on compost treatment (Willson, et al., 1999). Nitrogen applied as compost is organic N and must be converted to inorganic N.

Differences due to N management persisted into the following growing season. Data collected prior to tillage and compost application revealed higher nitrification potentials on fertilizer vs. compost treatments. This could be do to larger quantities of residues in fertilizer treatments. Crop residues have contained more than 100  $\text{kg N ha}^{-1}$  in previous seasons (Willson, et al., 1999).

Treatments with cover crops had significantly higher nitrification potentials on a seasonal basis ( $P = 0.05$ ). This may be due to the added N contribution from cover crops. The N content of crimson clover in October of 1994 and 1995 averaged across management treatment was 40  $\text{kg N ha}^{-1}$ . The N content of annual ryegrass for the same period was equivalent to 15  $\text{kg N ha}^{-1}$ . Red clover on wheat treatments was harvested in the fall of 1997. This left little biomass to contribute to soil inorganic N in the spring of 1998.

Systems with lower nitrification rates will have higher levels of plant available N in ammonia form. Across the 1998 growing season, compost treatments had a greater % of inorganic N derived from  $\text{NH}_4^+$  as compared to N fertilizer treatments. Differences appeared to be small with the exception of 1<sup>st</sup> year corn. Lower levels of nitrate tend to reduce leaching which allows for greater crop N uptake. Higher  $\text{NH}_4^+$  levels do not hinder row crop growth. There is some evidence of preferential uptake of  $\text{NH}_4^+$  over  $\text{NO}_3^-$  in certain species of row crops dependent upon growth stage. Uptake in corn is cultivar and growth stage dependent. Prolific corn plants at the grain fill stage are inefficient in taking up  $\text{NO}_3^-$  (Pan et al., 1984). A combination of  $\text{NH}_4^+$  and  $\text{NO}_3^-$  has resulted in small but measurable yield increases in corn, 3-9% (Barber et al., 1992).

### **Potential Impact of Research:**

The shaken slurry method of assessing nitrification potentials provides information of agronomic significance. Laboratory measurements of nitrification potentials were on average 10 fold greater than field estimates of nitrification rates. Field estimates were based on a growing season. Our research indicates that sustainable agriculture practices change the population size of microorganisms that control nitrification. Thus, a farmer may be able to employ management practices that favor low nitrification rates. Prevention of conversion of  $\text{NH}_4^+$  to  $\text{NO}_3^-$  may result in decreased leaching of N into groundwater and increase the amount of inorganic N taken up by crop plants.

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### ***Nitrate leaching under Integrated Compost and Integrated Fertilizer Systems.***

Jeff Smeenk and Richard Harwood

Lysimeters buried in the cover side of each of the integrated compost plots and the integrated fertilizer plots have been collecting soil water leaching samples since the LFL experiment began in 1993. These leachate samples have been analyzed for their nitrate-N contents. By recording the volumes collected and their respective nitrate concentrations we can determine the management system's contribution to nitrate groundwater contamination. The collections from 1993 probably reflect the nitrate contribution from the 1992 alfalfa crop rather than the contribution of the 1993 crop so the 1993 data is not used. Likewise the leachate associated with the 1998 crop will not be collected until late April 1999, so the 1998 data is also not included.

The cumulative nitrate leaching graph below shows several trends.

- 1.) Compost tends to leach less nitrate-N than does fertilizer. Only in 1st year corn and wheat are the cumulative graphs close in height. Some of the leaching similarity in 1st year corn might be due to the contribution of the red clover that was interplanted with the previous wheat crop. Neither the composted wheat nor the fertilized wheat leached significant nitrate-N. This is probably due to wheat's aggressive water scavenging ability. There is very little leachate collected from the wheat plots.
- 2.) The environmental conditions of the growing season influences the amount of nitrate leaching from each crop (strong crop by year interaction). For example, composted 1st year corn only leached about 25 lbs N/A in the >94-95 growing season while composted 1st year corn leached over 95 lbs N/A during the >95-96 season.
- 3.) All fertilized corn leaches more than the fertilized soybean plots but only the composted 1st year corn leaches more than the composted soybean plots. The soybeans in the integrated fertilizer plots do not receive any fertilizer and the soybeans in the integrated compost plots don't receive any compost. What is leached under any of the soybean plots is either legacy nitrate from the previous crops or nitrate that is being produced by the soybean plots.

### ***Managing Nitrogen Mineralization And Biologically Active Organic Matter Fractions In Agricultural Soil***

Thomas C. Willson

PhD Dissertation submitted to Michigan State University

## **Dissertation Abstract:**

Integrated cropping systems use biological resources such as organic fertilizers, nitrogen fixing plants, and crop and cover crop residues to reduce the need for chemical inputs and improve sustainability. This research explores the effect of integrated management on nitrogen mineralization in a variety of corn-based agricultural rotations and early successional treatments at the Kellogg Biological Station (KBS) in Southwestern MI. Part 1 defines the effect of management on the seasonal dynamics of nitrogen mineralization potential (NMP), the intrinsic ability of a soil to mineralize N over time (ideally a growing season). Measurements of NMP, based on the accumulation of inorganic N in soils incubated under aerobic conditions for 10, 30, 70, 150 and 310 days at 25 EC, are evaluated using 1st order mineralization kinetics and repeated measures analysis of variance. Nitrogen mineralization potential was greatest in the spring and lowest in the fall in all treatments. It increased in response to compost additions, was greater in low-input rotations with cover crops than in conventional rotations, and was greater in successional treatments without tillage than in tilled succession or agronomic treatments. During a corn-corn-soybean-wheat rotation, NMP was lowest under 2nd year corn and highest under wheat and 1st year corn, reflecting both legume inputs and the lack of spring tillage in wheat. Part 2 of the research found that macroorganic matter was correlated with NMP in most treatments, but that microbial biomass was not. The strongest correlation ( $r^2=.41$ ) was between macroorganic C in the 53-2000 (m size class and inorganic N accumulation in 150 day incubations. Macroorganic matter increased more rapidly after compost additions than NMP, but was less affected by residue inputs. Part 3 of the research found that conventional fertilization produced higher corn and wheat yields and greater leaching loss than additions of leaf and dairy compost. Net annual N mineralization (calculated from plant uptake and leaching loss) was greater in the compost treatments, but N availability was low because of lower than expected compost mineralization (9% yr<sup>-1</sup>). Nitrogen mineralization was greatest in years with corn production and lowest in years with soybean and wheat production, reflecting (in part) differences in residue input from the previous crop. Much of the variation in N mineralization could be predicted by laboratory measurements of NMP and macroorganic matter, particularly total macroorganic N (53 - 2000 (m), potentially mineralizable organic matter (No), and N mineralization predicted in 70 and 150 day incubations based on the 1st order kinetics. Leaching loss (October through September) was best predicted by initial inorganic N and total inorganic N (initial plus mineralized) in incubations performed after sidedress fertilization in the preceding season. This research shows that N mineralization varies appreciably within and between growing seasons, and responds predictably to integrated agricultural management.

## CHAPTER 1

### **Seasonal Changes in Nitrogen Mineralization Potential in Agricultural Soils: ANOVA and Non-Linear Regression Analysis of Management Effects**

#### ABSTRACT

A soil's nitrogen mineralization potential (NMP) changes over time in response to the addition and decomposition of organic material. We used non-linear regression and repeated measures analysis of variance to explore seasonal changes in NMP in field experiments in Southwestern MI. In the analysis of variance, NMP was based on the average accumulation of inorganic N in 10, 30, 70 and 150 day aerobic incubations at 25 (C. This was 29% greater in agronomic treatments receiving compost than in inorganically fertilized treatments after 3 years of management, and 32% greater in corn-soybean-wheat rotations with cover crops than in corn-soybean rotations without cover crops after 5 years. A 6th year old-field succession had 50% greater NMP than either an annually tilled succession or an agronomic rotation. There were strong seasonal changes in NMP in all treatments with 65% greater accumulation in June than October samples in 1994 and 39% greater accumulation in April than September samples in 1995. The kinetics of N accumulation generally fit the single-pool exponential model  $N_t = N_i + N_o (e^{-t/MRT})$ , where  $N_t$  is the inorganic N at time  $t$ ,  $N_i$  is the initial inorganic N,  $N_o$  is the pool of mineralizable organic N and MRT is the steady-state mean residence time of  $N_o$ . However, lower than expected mineralization at 10 and 30 days had the effect of inflating estimates of  $N_o$  and MRT in some incubations. Although we present several improvements in non-linear regression analysis, neither  $N_o$  nor MRT were themselves reliable indicators of NMP.

## CHAPTER 2

### **Managing Biologically Active Soil Organic Matter Fractions for Sustainable Crop Production**

#### ABSTRACT

We sampled agricultural and plant successional experiments in Southwest MI over a two year period to study the effects of alternative management practices on microbial biomass and macroorganic matter. Microbial biomass was determined by the chloroform fumigation, incubation method, and macroorganic matter was defined as the C and N content in sand-size soil separates. Microbial C decreased during a drought in 1994, and was greater in treatments receiving compost than fertilizer in 1995. Microbial C:N ratio was lower in July and November (6.0) than in April and September (7.3), and lower in successional treatments without tillage (5.2) than in agronomic treatments (6.7). Microbial biomass accounted for 2.6% of soil C and 4.9% of soil N in 1995. Macroorganic matter accounted for 19.7 % of C and 14.8% of N. Its C:N ratio was 20.8 in a never tilled successional treatment and 16.0 in other soils, 17.0, on average, in the 250 - 2000 (µm fraction) and 15.5 in the 53 - 250 (µm fraction). Macroorganic C increased after compost additions, and was greater in successional plots without tillage than in tilled treatments. It was strongly correlated with N mineralized in 70 and 150 day aerobic incubations. Microbial biomass was not. There was greater N mineralization per unit macroorganic matter in April and November than in September and October. This suggests that macroorganic matter could be used to estimate N mineralization if combined with information about recently deposited plant residues.

## CHAPTER 3

### **Biological Indicators of Crop Performance, Nitrogen Mineralization, and Leaching Loss in Integrated Cropping Systems**

#### ABSTRACT

Integrated cropping systems use biological resources such as organic fertilizers, nitrogen fixing plants, and crop and cover crop residues to reduce the need for chemical inputs and improve sustainability. We present crop performance, and N cycling data for corn (*Zea mays* L.) monoculture and corn-corn-soybean (*Glycine max* L.) wheat (*Triticum aestivum* L.) rotations receiving compost or inorganic fertilizer, with and without cover crops. Laboratory measurements of microbial biomass, macroorganic matter, and N mineralization potential (NMP) were evaluated for their ability to predict yield, leaching loss, and N mineralization under field conditions. Nitrogen mineralization was calculated using the equation:  $N_{min}^* = N_{harvested} + N_{residue} + N_{leached} - N_{fertilizer} - N_{fixed}$ , which does not include losses due to denitrification or volatilization. Leaching was measured using 0.3 m diameter, intact core lysimeters installed 0.3 m below the surface to facilitate tillage. The rotation produced about the same mineralization and leaching loss as the corn monoculture. The use of compost increased mineralization and decreased leaching loss. It produced equal yields in 1st year corn and soybean, but lower yields in 2nd year corn, continuous corn and wheat. Field N mineralization was correlated with predicted N mineralization in 70 and 150 day aerobic incubations and with macroorganic N in the 53-2000 (µm size class) across all dates. Correlations between NMP and both leaching loss and yield were often negative because of lower N availability in the compost treatment. However leaching loss was positively correlated with inorganic N and 10 day N mineralization in the previous summer.

#### THESIS SUMMARY

In these course textured soils, potential and actual N mineralization are closely linked to the supply of organic materials from above and below ground plant residues. Nitrogen mineralization potential (NMP) was greatest following residue incorporation in the spring and fall and lowest at peak plant biomass (late summer). It significantly increased in systems with untilled fallow including the wheat-clover, wheat-fallow, and historically tilled succession (HTS) treatments. Nitrogen budget analysis suggests that much of the difference in N mineralization over the course of the corn-corn-soybean-wheat rotation at the LFL can be explained by differences in the return of residue-N from the previous crop.

The use of external organic inputs in the form of composted leaves and dairy manure increased mineralization (NMP and  $N_{min}^*$ ) at the LFL. Application rates were sufficient to provide high productivity in 1st year corn when combined with inorganic N from the decomposition of red clover following wheat, but insufficient to produce the same productivity in 2nd year corn, continuous corn or wheat as was found

in the fertilized system. Compost appears to have provided less than 50 kg N ha<sup>-1</sup> yr<sup>-1</sup> between 1994 and 1996, which is consistent with a mineralization rate of approximately 9% per year.

Tillage affects these systems directly by incorporating residues and disrupting soil aggregates and indirectly by altering the plant community. The incorporation of residues resulted in a temporary reduction in the C:N ratio of microbial biomass and an increase in macroorganic matter and NMP. In unmanaged systems, the lack of tillage promotes the growth of perennial vegetation that appears to favor the storage of N below ground. In tilled systems, the longer period between tillage events in the wheat-fallow and wheat-clover systems promotes a more robust growth of winter cover species and therefore greater supply of NMP within the system and a greater supply of N to the following corn crop. The lack of spring tillage in wheat also increases the temporal continuity of the rhizosphere and reduces the disruption of soil aggregates, which may increase the storage of labile organic N in the soil.

Our attempts to find practical indicators of N mineralization in the field have met with mixed success. In general, mineralization in 70 and 150 day aerobic incubations provide the best indication of mineralization potential and are similar to the average of 10, 30, 70, and 150 day incubations used in the ANOVA in chapter one. However these measurements are time consuming and may be impractical in many cases. As defined in this study, measurements of macroorganic matter are quick and easy and provide more information about NMP than do total C and N or microbial biomass. However, macroorganic matter measurements may underestimate the contribution of recently incorporated residues, particularly legume residues, which may release large amounts of N that does not contribute directly to macroorganic matter. Macroorganic matter measurements could be used to estimate N mineralization for the purposes of making fertilizer recommendations if they are combined with information about the productivity of the previous crop or cover crop. Additional testing will be required to determine whether macroorganic matter provides a useful index of N mineralization potential across soils and indifferent climatic conditions.

### ***Cover Crop-Enhancement Of Strategically Released Soil Nitrogen In Corn Production Systems***

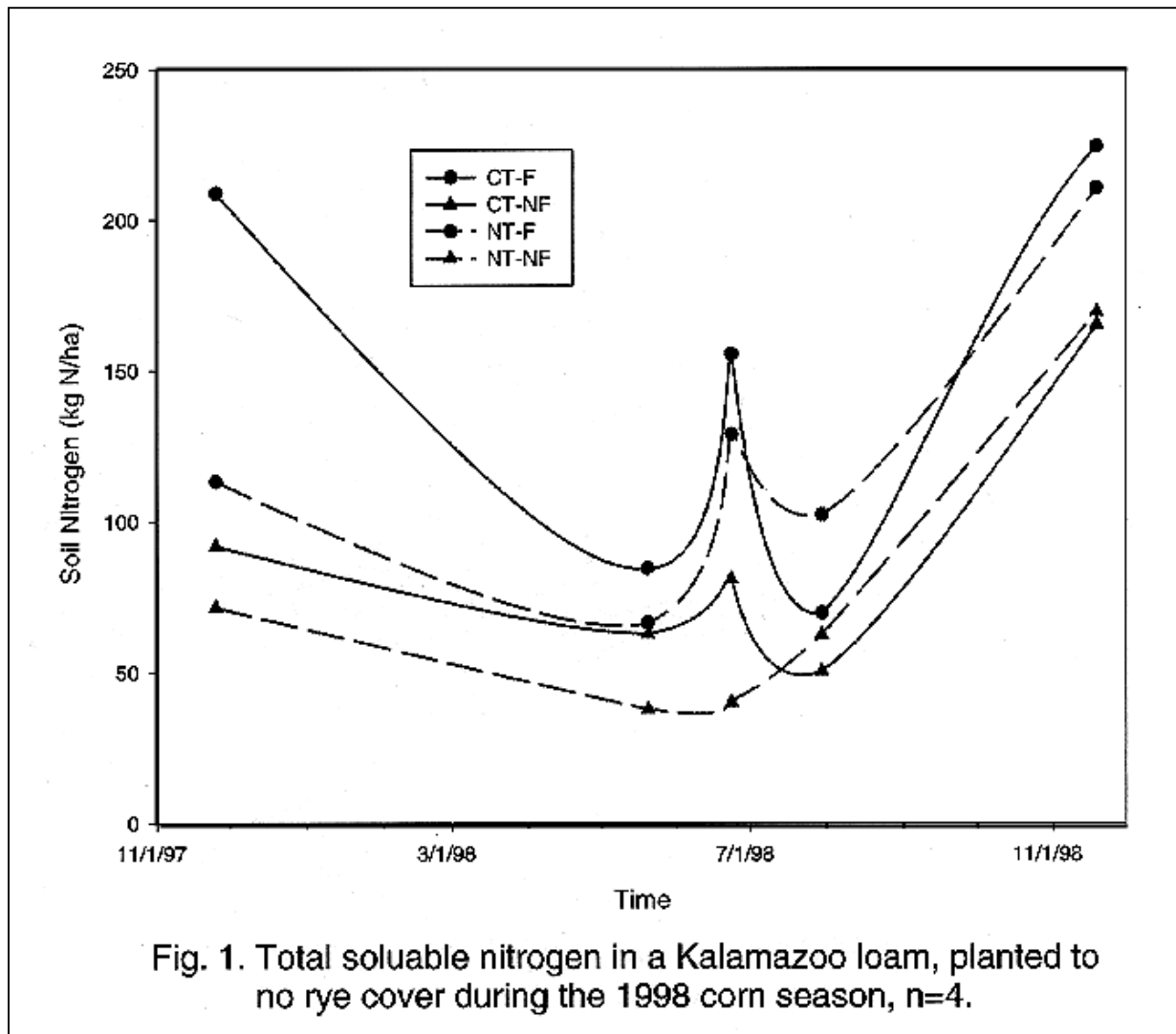
Alvin Smucker and Yasemin Kavdir

Crop and Soil Sciences Department, Michigan State University

**Effects of rye cover on corn populations, plant growth, and weed control:** Fall-planted rye cover crop was reseeded at the rate of 55 lbs per acre in April. Roundup Ready® corn hybrid, Dekalb 493 was planted at the rate of 26,000 seeds per acre. Corn rows were planted at 28-inch row spacings which were band sprayed with Roundup® (two quarts/a). Corn seedling emergence rates were similar on all tillage, rye cover, and N fertilizer treatments. Later, a mixture of Roundup (two quarts/a) and atrazine (one quart/a) was broadcast-applied to the entire area at both the two- and four-leaf stages of corn growth. One year results indicate that comprehensive spraying of this herbicide mixture on the remaining rye cover crop, at either of the corn leaf stages, had no significant affect upon final plant populations, plant growth, nor yield of the subsequent corn crop. Therefore, we believe that companion rye grass of Roundup Ready corn can be spray-killed anytime between the second and fourth leaf stages.

**Rye cover crop retention of excessively high soil nitrogen contents:** Cover crop removed 33 percent more soil nitrogen from the Ap horizons during the first two weeks following the band application of N fertilizer, Table 1. Much of this N was retained by the rye cover crop. Nitrogen distribution within the plant and soil continuum was: 14 percent in the rye cover, 29 percent in the corn, and 57 percent in the soil. Although some soil nitrogen, especially that which had been leached to soil depths beyond 30 cm, could not be absorbed by the shallow roots of the rye cover crop, the rye cover crop absorbed, accumulated, and released an average of 25 pounds of N per acre, during the corn growing season of 1998. Total quantities of N absorbed by rye plants were similar for all treatments. Although N contents in the rye cover crop plants from N fertilized treatments ranged from two percent for non-tilled treatments to 2.5 percent for conventionally tilled treatments, these different N concentrations were offset by plant biomass. Soil nitrogen contents ranged from 63-200 pounds per acre, in the Fall of 1997, to as low as 40-155 lbs/a one month following N fertilization at planting, Figs. 1 and 2. These reductions in soil N contents greatly

diminish the risk of greater nitrate leaching during periods of heavy Spring and early Summer rainfall events.



**Corn grain yields:** Yields were similar for the rye and no rye cover crops on conventionally tilled soils fertilized at 130 lbs/a. Cover cropping increased corn yields 23 percent when 130 lbs/a of N fertilizer was added at planting and 74 percent (data not shown) when no N fertilizer was added to no-tilled treatments, Table 2. Rye cover cropping nearly doubled the N translocation efficiency of plant N into grain yields. This was not observed for the N fertilized conventionally tilled treatments. Although plant biomass of corn was the same for N fertilized treatments for both CT and NT, plant nitrogen contents were significantly higher when no cover crop was present.

**Conclusions:** Fall plantings of rye cover crop immediately following harvest will retain from 25 to 60 pounds of N per acre for the corn crop planted in the following Spring. These N savings increase corn yields, especially in no-tilled soils. Combined root plugging of soil macropores and rye cover crop absorption of N will save Michigan farmers substantial quantities of fertilizer N as well as dramatically reduce the risk for groundwater contamination in areas where more than 125 lbs N per acre are added annually to the corn growing regions in Michigan.

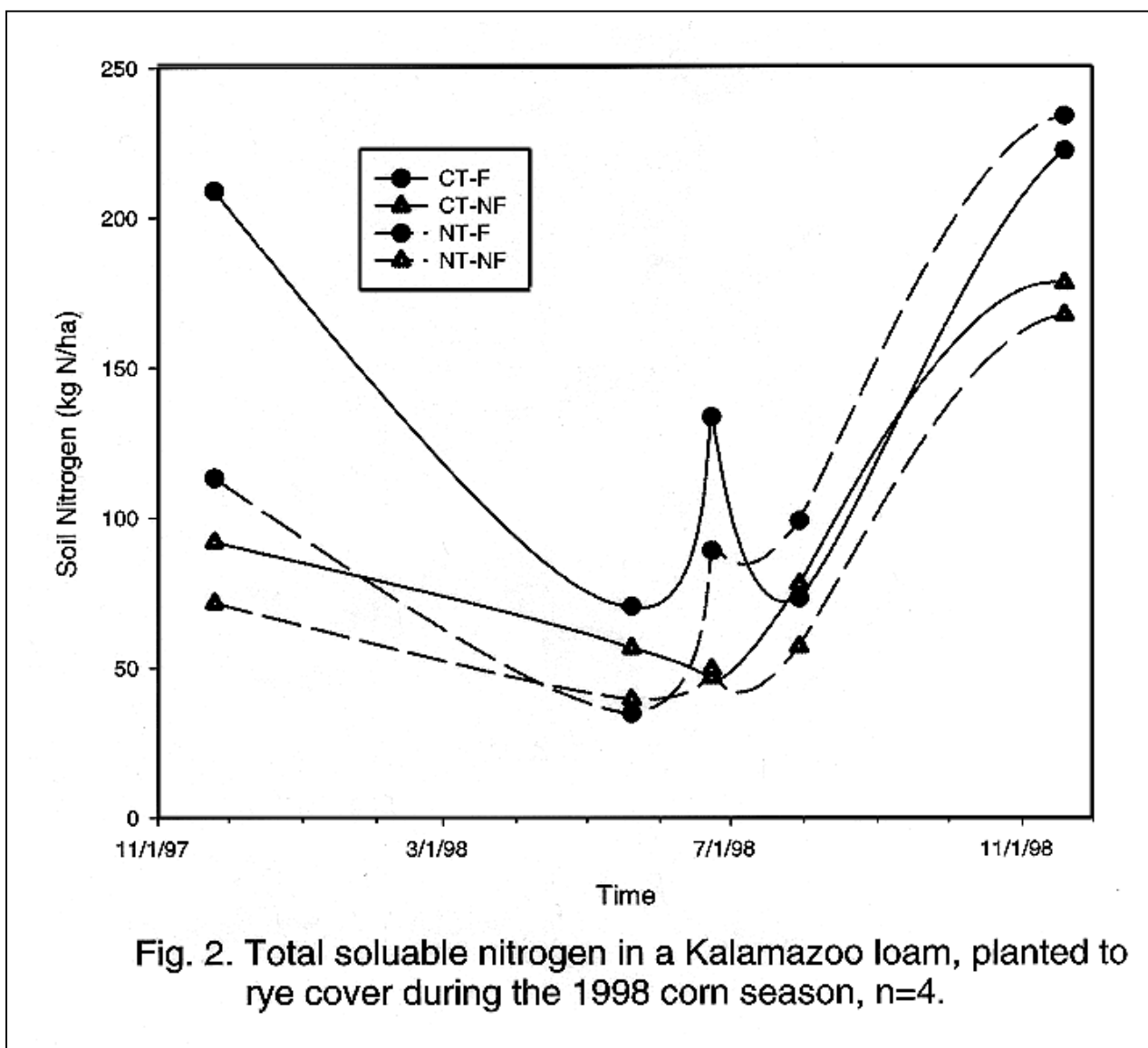


Table 1. Rye cover crop interception of soil N contents in the Ap horizons (0-8 inches) during the first two weeks following the applications of 130 pounds of N per acre. KBS Interactions, 1998, n=4.

Tillage treatments	No rye cover		Rye cover	
	Ap horizon	Total Soil N	Ap Horizon	Total Soil N
Kg per ha				
Conventional	94 (24)*	156 (39)	70 (8)	133 (41)
None	92 (23)	129 (32)	55 (3)	89 (14)

\*Values in parentheses are standard errors of their respective means.

Table 2. Cover crop modifications of corn yields grown in N fertilized (130 lbs/a) conventionally tilled (CT) and no-tilled (NT) treatments of a Kalamazoo loam soil. KBS, Interactions 1998, n=4.

Tillage treatments	No rye cover		Rye cover	
	Grain Yield	Plant N	Grain Yield	Plant N
	lbs/acre			
Conventional	3955 (490)	58 (4)	3994 (189)	54 (9)
None	2467 (325)	47 (3)	3063 (248)	35 (2)

\*Values in parentheses are standard errors of their respective means.

### ***Tillage Rotation In A Corn-Soybean Rotation***

Francis J. Pierce

Crop and Soil Sciences Department, Mich. State Univ. Extended Abstract

While chisel plowing (CP) and no-tillage (NT) are used extensively by many Michigan farmers as their tillage management system in some or all of their grain crop production operation, exclusive or "continuous" use of a given tillage system is uncommon as many farmers rotate tillage for a variety of reasons. Tillage rotation was introduced into a long-term tillage study conducted since 1981 at the Kellogg Biological Station (KBS) comparing tillage systems for the production of corn and soybean grown in rotation with and without a history of manure application. This tillage study was conducted from 1996 to 1998 comparing six tillage treatments including: (1) continuous spring CP (since 1981); (2) fall CP; (3) fall moldboard plow (MP); (4) continuous NT (since 1981); (5) NT soybeans, spring CP for corn; (6) NT corn, spring CP for soybeans. Bedding straw manure had been applied annually to half of each tillage plot from 1981 through the 1988, when manure applications ceased.

Drought stress occurred each year resulting in relatively low yields of corn and soybean throughout this study. While spring CP has been the standard tillage practice for the sandy, highly erodible soils of southwest Michigan, spring CP had the lowest yields of corn (96 bu/acre) and soybean (29 bu/acre) over three years. Continuous NT or rotating spring CP with NT produced the highest yields in most years and over the three year period (107-108 bu/acre for corn and 31-33 bu/acre for soybeans). Since rotating tillage was better whether chisel plowing occurred in the corn or in the soybean part of the rotation, there is value in the rotation of CP with NT regardless of crop sequence. Therefore, NT is important for the management of this soil whether it is used continuously or in alternating years. Manure application, even though it ceased in 1988, continued to have a positive impact on corn and soybean yield, increasing corn 15 bu acre<sup>-1</sup> over the three year period. The impact of manure on soybean was smaller and inconsistent among years.

Manure increased soil test phosphorus (P) at all depths but not soil test potassium (K). Manure increased soil carbon (C) in the surface 2 inches from 0.59 to 0.69 % in CP and 0.87 to 1.60 % in NT. Soil C was higher under NT (0.82%) in the 2 to 4 inch depth than under CP (0.67%) but tillage had no effect on C in the 4 to 8 inch depth. No-tillage stratified soil test P and K as is commonly reported for NT. The NT and rotational tillage plots had higher soil pH in the soil surface due to surface lime applications over time but lower pH in the deeper depths due to lack of movement of lime. Tillage affected soil bulk density in many ways, most strikingly with NT decreasing bulk density in the surface 2 inches to levels in MP (1.41 g/cm<sup>3</sup>).

### **Research Impact**

The most common primary tillage practice for this area of Michigan is CP in the spring. No-tillage is very common for soybeans, less so for corn. Based on these results, the use of continuous spring CP appears to be detrimental to soil and crop productivity and its use is not recommended for this soil. Overall, the use of NT and manure had positive impacts on soil quality and corn and soybean yields at

this site and should be used either continuously or in rotation with CP in alternative years.. Benefits of manure nearly 10 years after application ceased were apparent in corn but not soybean yields and but were consistently evident in soil fertility. Manure effects are an indication of the soil quality benefits of primarily by adding soil organic matter.

### **Publications**

No other publications or presentations were made in regard to these studies were made this past year. A manuscript is in preparation for submission later this year.

### **Funding Acknowledgment**

This research was funded for only the 1997 year by the Corn Marketing Program of Michigan and the Michigan Soybean Promotion Committee. I thank both organizations for their support for this research.

### ***Impact Of Animal Manure And Inorganic Fertilizer On Nitrate Leaching In A Corn-Alfalfa Rotation***

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### **Justification and Objectives**

An accurate estimation of the amounts of nitrogen, mainly nitrate, leached through agricultural land is critical to environment impact studies. Nevertheless, this parameter is not easy to measure unless large draining lysimeters are installed. The drainage of water from below the crop root zone in agricultural fields carries with it water soluble chemicals that can be the sources of groundwater contamination. Although nitrates are almost always present in groundwater, the continued increase in nitrate concentration in managed agricultural land can lead to concentrations above acceptable human health standards. Organic sources of nitrogen have been considered superior to inorganic fertilizers, partly because the decomposition rate of organic sources is slower. There has been little research to quantify nitrate leaching under field conditions from animal manure applied as the primary source of nutrients in intensive crop production systems.

It is possible that when inorganic sources of N fertilizer are used with the concept of a supplemental source of N to the natural supply from soil mineralization, nitrate leaching may be reduced more than through use of organic N. Because organic N is converted to inorganic N at a much slower rate than inorganic N, large quantities have to be added to the soil to provide enough nutrients for rapidly growing plants such as corn during their relatively short time of uptake when demand for inorganic N is high.

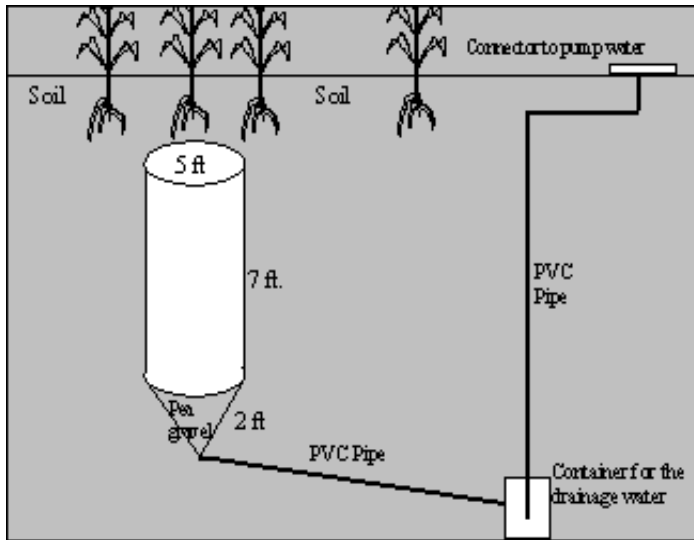
The objective of our study is to quantify how raw and composted animal manure compares with using inorganic N fertilizer in influencing crop productivity and N leaching under field conditions in a corn-alfalfa system. The results are used to test simulation models of crop production and nitrate leaching with the view that the technology from this study can be transferred to other sites, soils and weather conditions.

### **Methodology**

A field facility with eight large lysimeters was installed in 1992 at the Kellogg Biological Station. The lysimeters (Fig 1) are large containers filled with undisturbed soil, buried near the north side of each experimental plot. The lysimeters capture all the water flowing through the soil, allowing us to measure the nitrate content in the drainage water. They consist of circular steel boxes 9 feet tall and 5 feet diameter. The boxes have open tops and are installed so that the tops are about 1.5 feet below the ground surface allowing normal tillage operations. The bottom of each lysimeter is closed except for a small opening through which the drainage water is channeled to a stainless steel container located to the side of and below the bottom of the lysimeter. Water is occasionally pumped from the container during which the volume is determined and samples taken for nitrate. To have an accurate estimation of nitrate leaching, we feel that it is necessary to have large lysimeters so the N uptake from the root systems and the drainage are representative for the treatment under study.

The corn plots were planted on April 22, 1998, with a population of 26300 plants/acre. The alfalfa crop was planted in May 1997, on the area previously planted with corn. The corn plots received conventional management (tillage and weed control) except for the fertilizer application. The treatments are shown in Table 1.

Drainage samples were collected periodically to measure the nitrate concentration in the water drained through the soil profile, and to calculate the total amount of nitrate leached over time for each single treatment in comparison. The nitrate concentration of the lysimeter leachate is obtained by flow injection technique using a QuickChem automated ion analyzer (Lachat Instruments, Milwaukee, WI).



**Figure 1.** Diagram of the lysimeter

**Table 1.** Summary of the treatments and results for the 1998 season.

Plot ID	Crop Type	Fertilizer		Drainage water inches	Total N Leached lb/acre	Biomass lb/acre
		Type	Amount			
1	Corn	No fertilizer	0	7.9	16.8	14948
2	Corn	Urea	120#/A	4.8	19.7	15479
3	Corn	Compost	30 ton/A	8.2	25.8	16635
4	Corn	Manure	18 ton/A	9.2	58.3	15965
5	Alfalfa	No fertilizer	0	8.3	61.2	7511
6	Alfalfa	No fertilizer	0	3.9	25.0	8348
7	Alfalfa	No fertilizer	0	2.4	12.6	6660
8	Alfalfa	No fertilizer	0	2.1	11.8	6385

## **Evaluating Several Cover Crop Cultivars To Corn Herbicides**

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Michigan State University and Kellogg Biological Station

### **Situation**

Ninety-five percent of pesticide use is for weed control. The Michigan State University/W. K. Kellogg Biological Station/Integrated Pest Management Cover Crop Program (MSU/KBS/IPM) is working with eight different farmers in southwest Michigan to explore strategies aimed at reducing herbicide applications. Most of this work involves evaluating ten-inch band herbicide applications to broadcast herbicide treatments, reducing herbicides use by 67 percent. Within these systems, cover crops are overseeded to enhance soil biological activity while decreasing weed populations. Through Extension winter meetings, we've heard from many farmers that they do not want to band herbicide, yet want to seed cover crops for weed control.

### **Methods**

A corn herbicide screen for cover crops has been initiated at the MSU/KBS. Twenty-three corn herbicide treatments (pre and post) were broadcast sprayed in strips and five cover crop species were seeded across these herbicide treatments. To simulate cover crop overseeding in corn, cover crop seeds were planted five weeks after the herbicide treatments and one week after post-emergence herbicide applications. These data will enhance our ability to select corn herbicides for specific cover crop cultivars for overseeding into broadcast herbicide corn fields. Since this is the second year for this experiment, these data will be collected and printed in an information sheet for 1999 winter meetings.

### **Objective**

Evaluate several cover crop cultivars tolerance to corn herbicides applied pre, post and post-post.

### **Cover Crop Species**

- Michigan mammoth red clover
- Annual ryegrass
- Crimson clover
- Medium red clover
- Hairy vetch

### **Injury rating**

Cover crops were evaluated two times for injury. A scale from 1-5 was used, where 1.0=no injury and 5=complete kill. Any cover crop that received an injury score of 3 or higher was considered unacceptable injury and was given an X in the table.

<b>PRE-EMERGENCE</b>	Mich. Mammoth	Annual Ryegrass	Crimson Clover	Medium Red Clover	Hairy Vetch
Atrazine	1.8	1.0	1.8	2.5	1.0
Lasso	1.5	1.0	X	2.5	1.0
Dual II	1.3	X	X	2.8	1.0
Frontier	1.3	1.3	2.7	1.7	1.0
Surpass	1.8	1.3	2.0	2.3	1.0
Prowl	1.2	2.0	2.0	1.5	1.0
Python	2.7	1.0	2.0	X	2.5
Bladex	X	1.2	2.0	X	1.0
<b>POST-EMERGENCE</b>	Mich. Mammoth	Annual Ryegrass	Crimson Clover	Medium Red Clover	Hairy Vetch
Banvel	1.8	1.0	2.3	1.7	1.0

Accent	X	2.0	X	X	1.0
Permit	X	1.5	X	X	1.0
Basis	X	1.0	2.8	X	1.0
Atrazine	X	1.2	X	X	1.0
Basagran	1.2	1.0	1.7	1.5	1.0
Buctril	1.2	1.0	1.5	1.2	1.0
Sencor	1.0	1.0	1.8	1.8	1.0
Stinger	X	1.0	X	X	1.8
Resource	1.0	1.0	2.2	2.2	1.0
Bladex	X	X	X	X	1.0
2, 4-D amine	1.3	1.0	2.0	1.5	1.0
Beacon	1.8	1.0	2.2	2.7	1.0

<b>POST-POST EMERGENCE</b> These treatments were used to evaluate which post herbicides would kill (control) the cover crops.	Mich. Mammoth	Annual Ryegrass	Crimson Clover	Medium Red Clover	Hairy Vetch
Accent	X	X	X	X	2.3
Atrazine	X	1.2	X	X	X
Basagran	1.5	1.2	2.3	1.5	1.2
Beacon	X	X	X	X	X
Buctril	1.8	1.0	2.7	2.5	X
Permit	X	1.2	X	X	2.5
Resource	2.0	1.3	X	1.9	1.2

<b>UNACCEPTABLE PREEMERGENCE INJURY</b>	
<b>Cover Crop</b>	<b>Herbicide</b>
Annual ryegrass	Dual II
Hairy vetch	No herbicides
Crimson	Lasso, Dual II
Michigan Mammoth	Bladex
Medium Red clover	Phython, Bladex

UNACCEPTABLE POSTEMERGENCE INJURY	
Cover Crop	Herbicide
Red clovers	Accent, Permit, Basis, Atrazine, Stinger, Bladex
Annual ryegrass	Bladex
Hairy vetch	No injury

POST-POST EMERGENCE (will kill)	
Cover Crop	Herbicide
Red clover	Accent, Atrazine, Beacon, Permit
Hairy vetch	Atrazine, Beacon, Buctril
Annual ryegrass	Accent, Beacon

### ***Red Clover's (Trifolium Pratense L.) Influence On Common Ragweed (Ambrosia Artemisiifolia) Population***

Dale R. Mutch and Todd E. Martin,

MSU Extension Land & Water Program, Kellogg Biological Station

#### **Abstract**

A field with an historically high common ragweed (*Ambrosia artemisiifolia* L.) population was planted to winter wheat. Four rates (0, 6, 9, 123 lbs/A) of three red clover (*Trifolium pratense* L.) cultivars were frost seeded. Following wheat harvest, each treatment was split into mowed and non-mowed subplots. In mid-September, common ragweed and red clover biomass and population counts were taken and common ragweed populations and red clover cultivar seeding rates in the mowed and non-mowed subplots were analyzed.

Each frost seeding rate (6, 9, and 12 lbs/A) suppressed common ragweed biomass similarly. Each red clover cultivar suppressed common ragweed biomass similarly.

#### **Introduction**

Common ragweed (*Ambrosia artemisiifolia* L.) is an annual weed problem following winter wheat in southwest Michigan. Producers often use herbicides for spring weed control in winter wheat. A more sustainable weed control practice would incorporate red clover (*Trifolium pratense* L.) into winter wheat. Red clover can be frost seeded into winter wheat with little or no impact on wheat yields, while harboring such beneficial insects as the lady beetle. Red clover consistently provides a stand of 140 or more plants/meter<sup>2</sup> and produces about 2,000 lbs/A of biomass by the following May. Plow-down nitrogen yields range from 89-178 lbs/A, which can supply the equivalent of 80-100 lbs. N/A (fertilizer replacement value) for a subsequent corn crop. Most wheat herbicides kill red clover, so the cover crops program at the Michigan State University W. K. Kellogg Biological Station (MSU/KBS) has initiated a study to evaluate how red clover seeding rates and varieties influence weed suppression.

#### **Objectives**

1. Compare c. ragweed suppression by three red clover cultivars frost seeded into winter wheat.
2. Evaluate each red clover cultivar at 6, 9 and 12 lbs/A for c. ragweed suppression.
3. Evaluate post wheat harvest biomass of c. ragweed and red clover as influenced by mowing vs. not mowing.

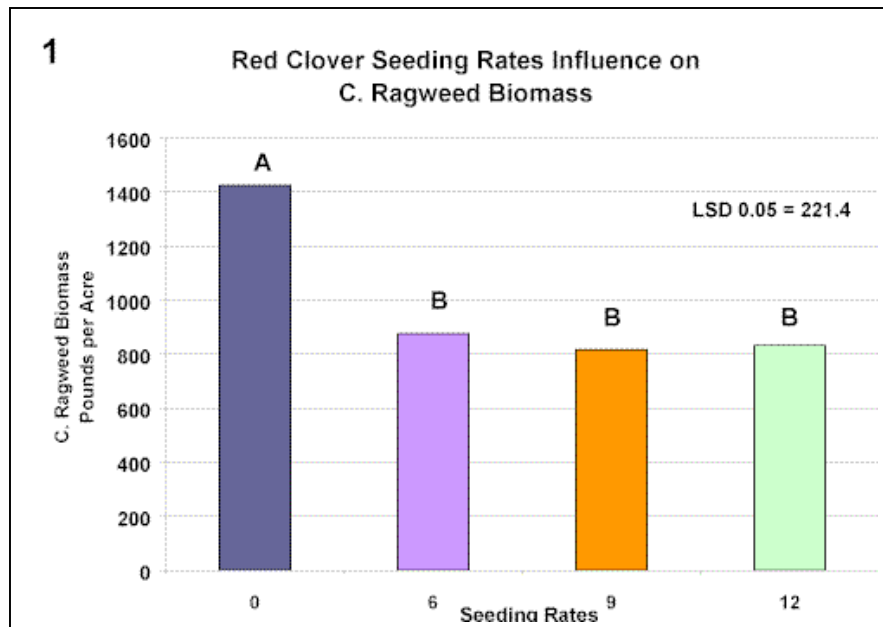
## Materials and Methods

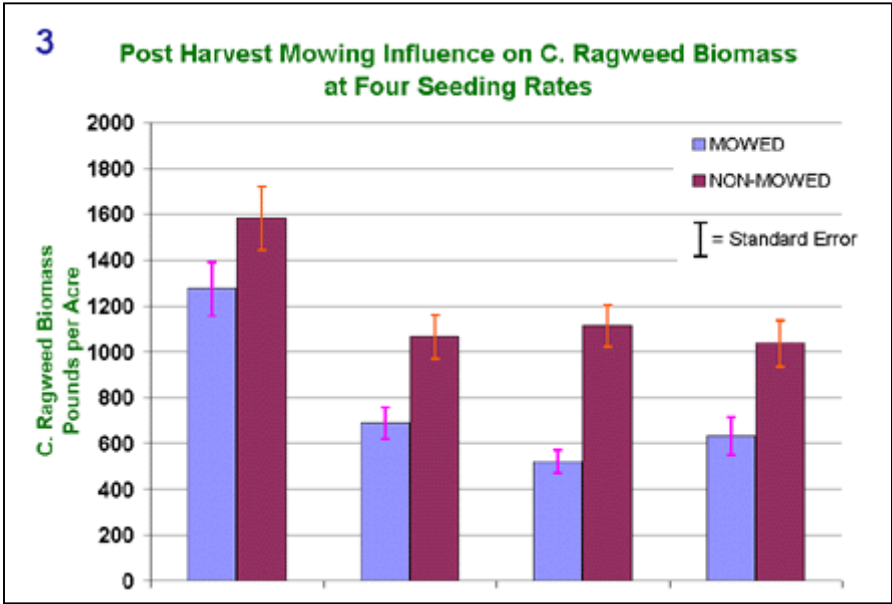
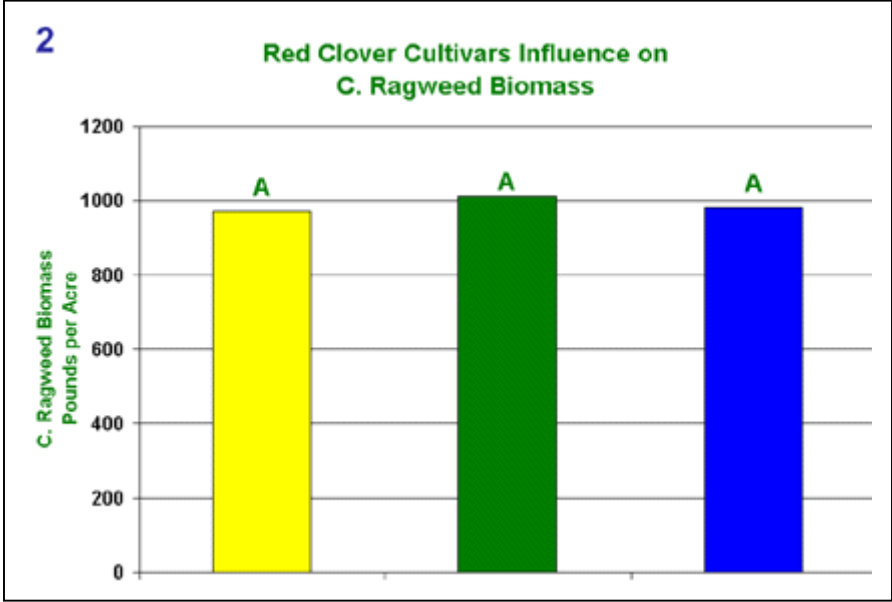
1. Wheat planted: October 15, 1997
2. Fertilized N-50 lbs/A actual: March 13, 1998
3. Frost seeded: March 16, 1998
  - a. Gandy air seeder
  - b. Plot size: 3x36 meter
4. Wheat harvested and yields taken: July 10, 1998
5. Mowed 10-foot wide strips with rotary mower to height of six to eight inches: July 28, 1998
6. Biomass of c. ragweed and red clover taken: September 18 and 22
  - a. 0.4 square meter samples were clipped to ground level in each plot.
  - b. Red clover and c. ragweed were separated and placed in paper bag, dried and weighed

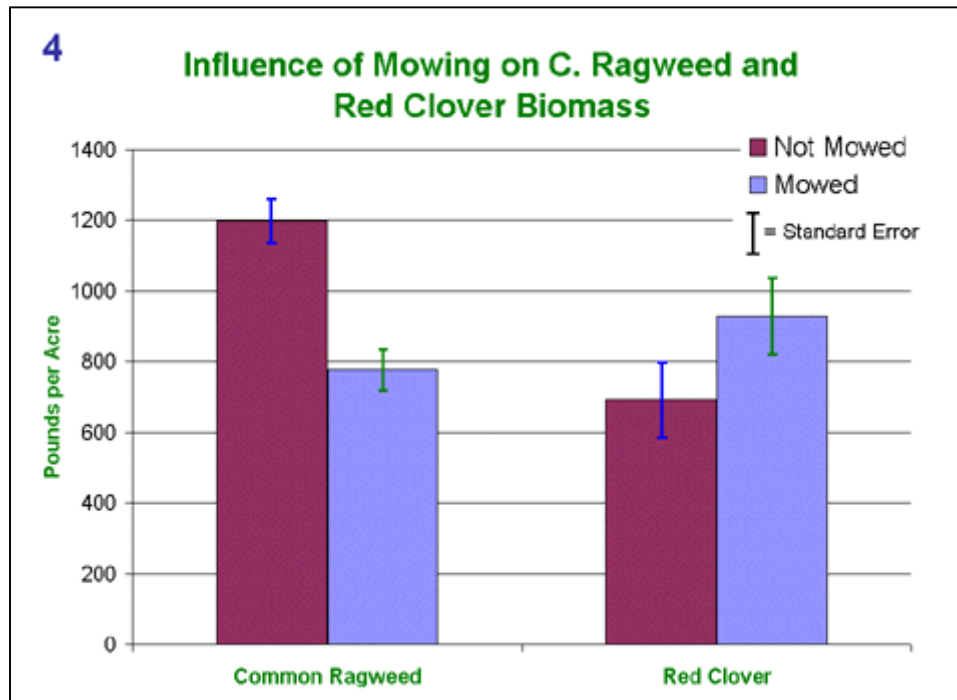
## Conclusions

- C. ragweed biomass was reduced when red clover was frost seeded into winter wheat (chart 1).
- Each frost seeding rate (6, 9 and 12 lbs/A) suppressed c. ragweed biomass similarly (chart 1).
- Each red clover cultivar in suppressed c. ragweed biomass similarly (chart 2).
- Post harvest mowing reduced c. ragweed biomass in all treatments, however larger differences were measured at all seeding rates of red clover (chart 3).
- Mowing reduced c. ragweed biomass, and increased red clover biomass (chart 4).
- KBS/MSU experienced drought conditions in July and August 1998. This experiment will be repeated in 1999.

Though red clover lowered c. ragweed biomass, farmers may not find these levels acceptable.







***Varying Ca Concentrations In Diets With Negative Cation-Anion Differences [By Feeding Hydrochloric Acid-Treated Soybean Meal (HCl-SBM)] Three Weeks Before Calving To Improve Peripartum Health And Lactational Performance Of Dairy Cows***

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**Justification and research hypothesis**

Feeding diets with a negative cation-anion difference (by supplementing dietary anions) in the late prepartum period to dairy cows has become fairly common practice in recent years. However, the optimal calcium concentration in anion-supplemented diets is unknown and a major question of dairy producers. Also, common anion sources (anionic salts) are not palatable and can reduce feed intake prepartum and peripartum health and lactational performance. We hypothesize that determining the most effective calcium concentration in the prepartum diet will improve cows' calcium status and postpartum performance. Additionally, supplementing anions with hydrochloric acid-treated SBM (HCl-SBM) will provide a more palatable source of anions, and improve calcium status, health and lactational performance of peripartum dairy cows; also HCl-SBM will supply needed dietary protein and energy. This could be a very attractive and cost-effective feeding method for dairy producers.

**Objectives:**

1. To determine the most efficacious concentration of calcium in the prepartum diet with supplemental HCl-SBM to improve calcium status, reduce metabolic disorders, and improve lactational performance.
2. To determine effects of feeding HCl-SBM during the last 3 wk before calving on pre- and postpartum feed intake, calcium status, incidences of metabolic disorders, and subsequent milk yield and reproductive performance.

### **Methods and results to date:**

We are about half way through the experiment. So far, 246 pregnant animals in two research farms (MSU Campus Dairy Farm and Kellogg Biological Station Dairy Farm) have been blocked by parity to one of five dietary treatments fed 19 d prepartum. Data for peripartum health measurements and milk yield (first 70 days of lactation) were collected. Postpartum parity (lactation number) distribution was: 88 first; 50 second; and, 108 third and greater. Prepartum basal diet fed once daily was 18% alfalfa haylage, 42% corn silage, and 40% concentrate, dry basis. Varying amounts of a mixture (16.7% of dietary DM) of hydrochloric acid-treated, heated-extruded soybean meal and heated-extruded soybean meal not treated with hydrochloric acid were used to make diets which would not (treatment A) or would (treatments B- E) change the cows' acid-base and calcium status. Dairy nutritionists use the dietary cation-anion difference (DCAD) calculation  $[\text{meq}:(\text{Na} + \text{K}) - (\text{Cl} + \text{S}) / 100\text{g of dietary dry matter}$  to indicate how much anion (e.g., Cl in the form of hydrochloric acid) is present. Treatment A contained no hydrochloric acid-treated, heated-extruded soybean meal, only untreated heated-extruded soybean meal was supplemented and the DCAD was positive. Treatments B through E contained hydrochloric acid-treated, heated-extruded soybean meal and had a negative DCAD. Graded amounts of calcium carbonate were used to vary dietary calcium concentrations in treatments C through E; treatments A and B contained no added calcium carbonate. From weekly ration samples collected thus far (through 309 d of experiment), average analyzed calcium (%) and DCAD of each treatment were: (A) 0.47, +17.5; (B) 0.47, -4.7; (C) 0.99, -4.9; (D) 1.51, -4.7; and, (E) 1.94, -4.9. Weekly urine pH measurements were used to adjust proportions of HCl-treated, heated-extruded soybean meal and HCl-untreated heated-extruded soybean meal to maintain pH between 6.0 and 6.7 for treatments B through E over time. Urine pH the wk before calving was: 8.1 vs. 6.3; 6.6; 6.6; and, 6.5 for A vs. B, C, D, and E ( $P < 0.01$ ). Prepartum DMI was not affected by treatment (27.7 pounds/cow per day), but was affected by parity ( $P < 0.01$ ). Caudal vein blood was collected within 24 h after parturition. Plasma ionized calcium was: 4.32 vs. 4.45, 4.50, 4.50, and 4.55 mg/dl for A vs. B, C, D, and E ( $P < 0.04$ ). Plasma Cl was higher in B through E than A throughout the prepartum period. Pre- or postpartum body condition and udder edema scores, cow BW, calf birth weight, and colostrum score were not affected by treatment. Overall incidence rates of ketosis (25.2%), retained placenta (8.5%), milk fever (6.1%), abomasal displacement (10.6%), or mastitis (5.7%) were not affected by treatment. Postpartum DMI was not affected by treatment (45.8 pounds/cow per d), but was affected by parity ( $P < 0.01$ ). Milk yield through 70 DIM was not affected by treatment (77.2 pounds/cow per d), but was affected by parity ( $P < 0.01$ ).

### **Preliminary summary:**

Feeding of HCl-treated, heated-extruded soybean meal effectively altered the acid-base status of prepartum dairy cows as indicated by reduction in urine pH (treatments B, C, D, E vs. A). Feed dry matter intake in the prepartum period was not affected negatively, unlike the problems often seen when anionic salts (e.g., calcium chloride, ammonium chloride, etc.) are used to make the DCAD negative. Pooled across cows of all parities, blood calcium concentration immediately after calving was higher for cows fed HCl-treated heated-extruded soybean meal prepartum compared with those that were not fed the HCl-treated material. No differences in any dependent variables due to dietary calcium concentration were detected thus far. If differences do in fact exist, approximately twice as many animals will be needed. More cows and more data will be collected in the second year of the experiment.

This project is funded partially by the Michigan Agriculture Experiment Station, Michigan Soybean Promotion Committee, and West Central, Ralston, IA.

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### ***House Mouse Habitat Use And Response To Mowing In The Agricultural Landscape***

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### **Introduction**

House mice are common in agricultural settings, using both fields and barns (Stickel 1979). Numerous studies have been conducted on house mice living in buildings (Bronson 1979) or agricultural fields (e.g. Krebs et al. 1995). However, few researchers have studied house mouse movements between barns and

fields (e.g. Reimar & Petras 1968), despite mounting evidence that some rodents can move greater distances than previously thought (Szacki et al. 1993). Although house mice occur in alfalfa fields (pers. obs.), no one has studied how harvesting practices affect their habitat use between barns and nearby fields. Understanding house mouse habitat use in barns and cropfields is an important step to modeling metapopulation structure in the agricultural landscape. Do harvesting practices effectively isolate house mice to individual barns or does sufficient gene flow for maintaining metapopulations occur despite activity in adjacent fields? Does the frequent removal of vegetative cover affect the population dynamics of mice occurring in barns and fields?

The objective of this study was to describe the habitat use of house mice occurring in barns and temporally heterogeneous agricultural fields (e.g. alfalfa). I present the results of trapping at the Kellogg Farm (i.e. Maggie's barn, B Avenue). I describe the habitat use of house mice using the barn and adjacent alfalfa field before and after multiple harvests. The data in this report represent a subset of the data from my M.S. thesis and should be useful in generating hypotheses about the effects of repeated harvests on the movements and density of commensal rodents (e.g. house mice) in agricultural landscape (e.g. *Peromyscus*; Merriam & Middleton 1981).

## Methods

During the 1997 and 1998 summers, trapping methods were designed to monitor house mouse habitat use relative to multiple alfalfa harvests. Sherman and Leather live traps fitted with cotton and oats were opened in barns and fields starting in the late afternoon (4:30-6 PM) and checked the following morning (6-8 AM). On dates when traps were left open through the day, I rechecked the traps one to three times depending on the weather conditions. During both years, traps located in fields were removed shortly before or on the morning of an alfalfa harvest. Traps were placed back into the fields soon after the fallen alfalfa was removed from the field and reopened periodically until the following harvest. Field grids were about 3-7.3 m from barn edges and varied in shape and size depending on the location and orientation of the barn relative to the field.

During the 1997 summer, trap grids were set within the barn (2 m spacing,  $n = 51-108$  traps) and in areas of the alfalfa field bordering the northern and eastern edges of the barn (7.6 m spacing,  $n = 161$  traps). Between 6 June and 22 August 1997, multiple cycles of trapping were carried out relative to the 11 June and 14 July 1997 alfalfa harvests. During each cycle, I checked traps in the barn for two to four days. I then checked the alfalfa field grid for two to four days before closing all traps for one to five days prior to the start of the next cycle. Between 24 August and 19 October 1997, traps were opened periodically in the alfalfa field and barn to monitor habitat use relative to a 1 September 1997 alfalfa harvest.

During 1998, trapping methods were changed to include simultaneous trapping of barns and fields at the Kellogg Biological Station (KBS) and two local farms. Barn traps were set along walls, on top and along straw bales and in areas of low human activity. Grids with 9 m spacing were set in the areas of alfalfa fields that bordered barns. At the Kellogg Farm, traps were set in the barn ( $n = 32-83$ ) on 34 nights and in the alfalfa field ( $n = 85-101$ ) on 50 nights before and after alfalfa harvests on 19 May, 6 July and 10-11 August 1998. During June, trapping effort in the barn was reduced because the population had not regenerated from a near extinction during 1997.

House mice were marked with a unique toe-clip/ear notch combination, weighed to the nearest gram with a Pesola spring balance, sexed and inspected for rump patches.

## Results

Habitat use patterns were based on all morning captures. Afternoon captures were not included in the analyses because traps were not always left open through the afternoon. Sex ratios within habitats were based on morning and afternoon trapping sessions. All trapping data were used to assess house mouse responses to alfalfa harvests.

### Habitat use

There were 95 individuals were captured 336 times in the barn and 31 individuals captured 45 times in the alfalfa field between 6 June and 19 October 1997. Between 19 May and 25 August 1998, 38 individuals were captured 130 times in the barn and 13 individuals were captured 27 times in the field.

### Sex ratio

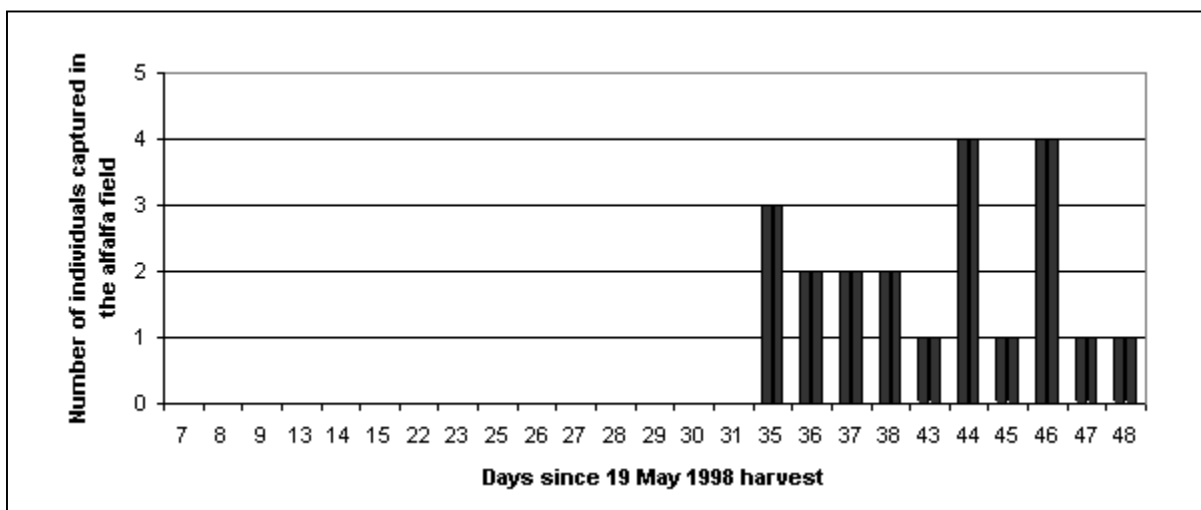
During the summer, female house mice may move into agricultural fields to establish nests or to find resources that are heavily guarded (e.g. food) or limiting (e.g. water) within barns. Consequently, I expected that more females than males would be captured in the alfalfa fields. Based on all trapping dates, more females than males were captured in the alfalfa field during 1997 (20 female: 13 male: 1 unknown sex) and 1998 (10 female: 4 male). During both years, however, the sex ratio in the alfalfa field was not significantly different from an expected 1:1 distribution (1997:  $Z = 1.48$ ,  $P > 0.05$ ; 1998:  $Z = 2.57$ ,  $P > 0.05$ ). Females were captured more frequently (average =  $1.65 \pm 0.21$  (SE) captures/mouse) than males (average =  $1.31 \pm 0.17$  (SE) captures/mouse) in the alfalfa field during 1997 (Mann Whitney U:  $U = 187.5$ ,  $U_{0.05(1), 13, 20} = 176$ ). During 1998, females also were captured more frequently in the field (average =  $2.67 \pm 0.75$  (SE) captures/mouse) than males (average =  $1.5 \pm 0.5$  (SE) captures/mouse), but the comparison was not significant (Mann Whitney U:  $U = 23$ ,  $U_{0.05(1), 4, 9(1)} = 30$ ).

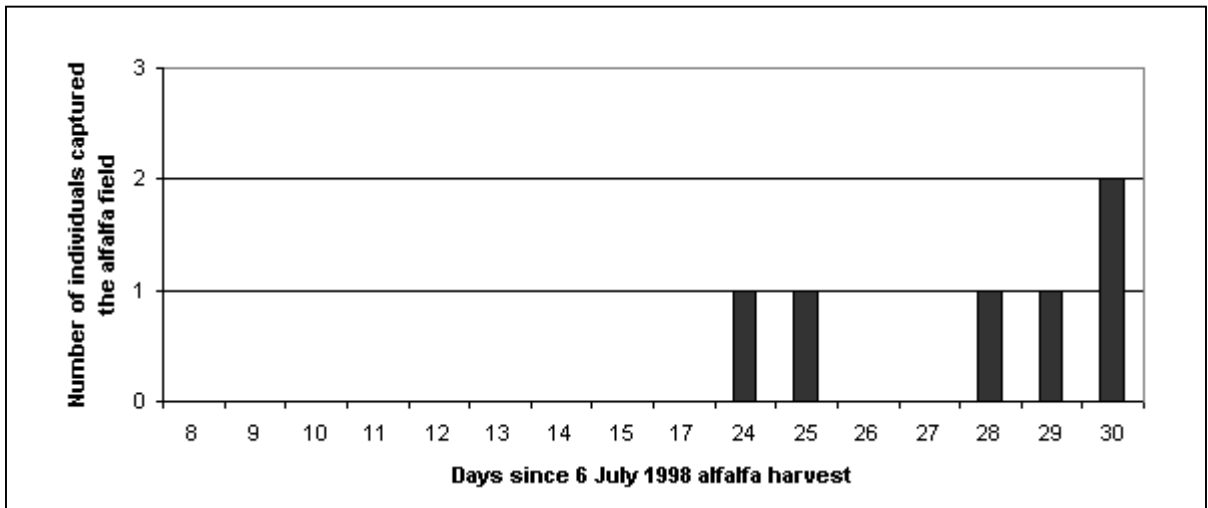
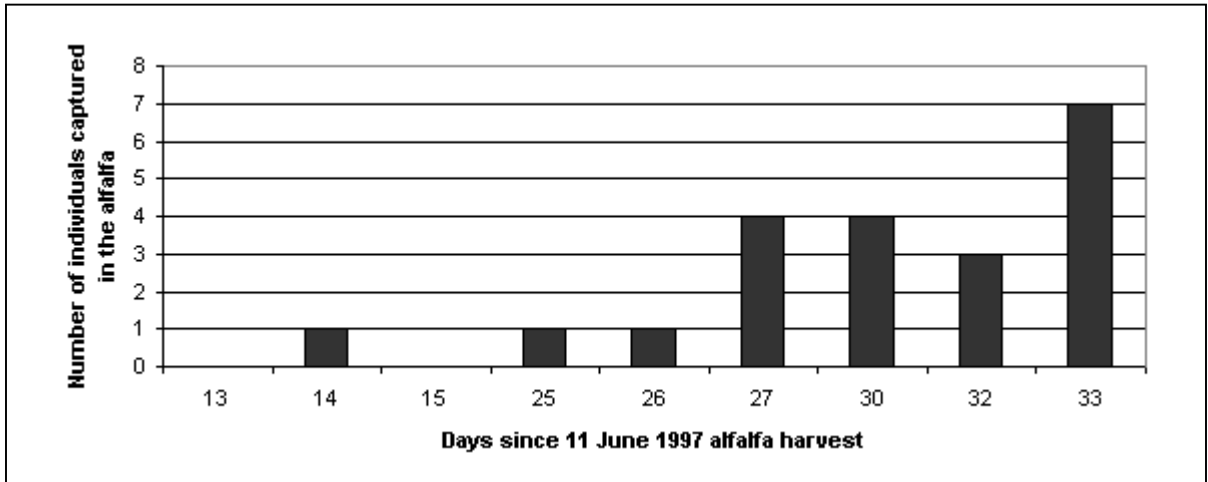
More females than males were captured in the barn during 1997 ( $n = 49$  females,  $n = 43$  males, 4 unknown sex) and 1998 ( $n = 21$  females: 17 males: 1 unknown sex). During both years; however, the sex ratio in the barn did not deviate from an expected 1:1 distribution (1997:  $Z = 0.39$ ,  $P > 0.05$ ; 1998:  $Z = 0.42$ ,  $P > 0.05$ ). Females were more frequently captured in the barn (average =  $3.88 \pm 0.50$  (SE) captures/mouse) than males (average =  $3.33 \pm 0.43$  (SE) captures/mouse) during 1997. The same trend was observed during 1998 (female average =  $3.86 \pm 0.54$  (SE) captures/mouse; male average =  $3.00 \pm 0.62$  (SE) captures/mouse).

### Response to cutting

House mice were rarely caught in the field when vegetative cover was low (Figure 1). Only one animal was captured in the field during the first trapping period (24 to 26 June 1997) conducted after the 11 June 1997 harvest (Figure 1). Mice were not captured in the field until the thirty-second day after the 14 July 1997 harvest and forty-second day after the 1 September 1997 harvest. During 1998, mice were not captured in the field until the thirty-fifth and twenty-fourth days after the field had been cut on 19 May and 6 July, respectively (Figure 1).

Between 24 June and 14 July 1997, the number of house mice using the alfalfa field increased with respect to the days since the 11 June 1997 alfalfa harvest (Figure 1). Only one individual was captured in the alfalfa field between 15 July and 1 September 1997. There was an upward trend in the number of house mice captured in the alfalfa field following the 19 May 1998 harvest (Figure 1). Following the 6 July 1998 harvest, all captures in the alfalfa field occurred between 30 July and 5 August 1998 (Figure 1). I did not trap the alfalfa field between 6 and 10 August 1998 so that I could track animals with radio-telemetry.

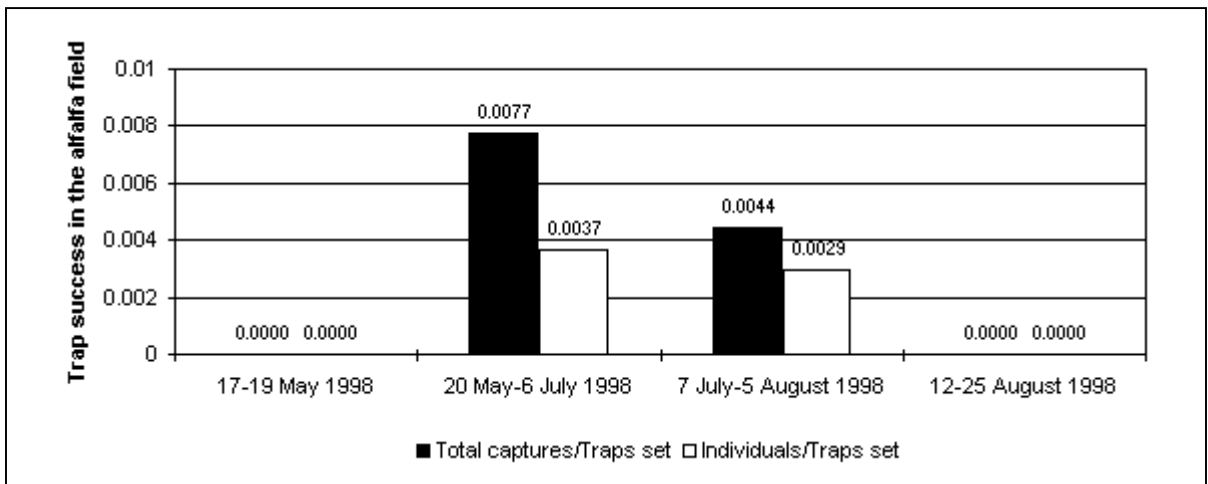
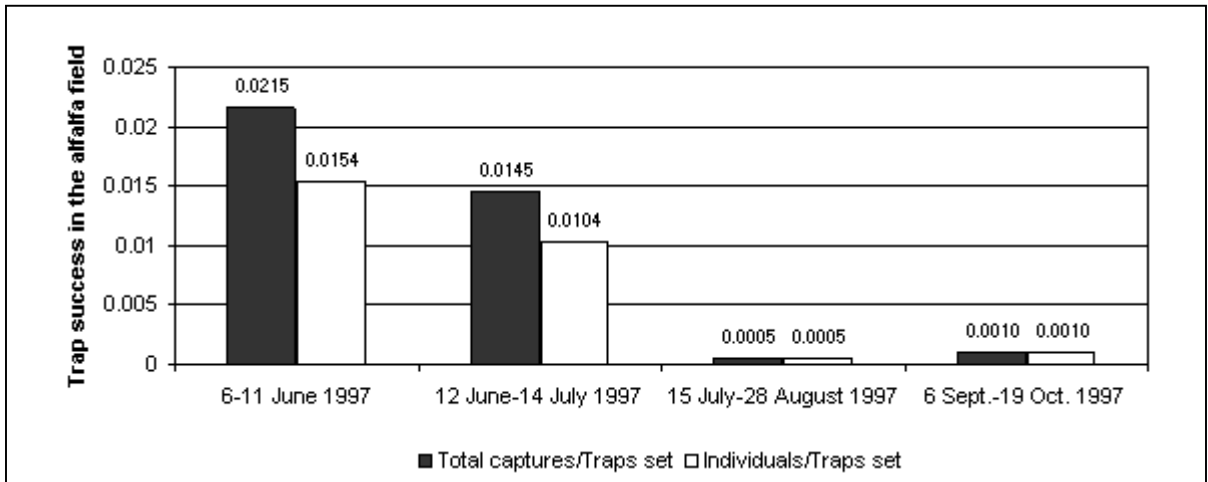




**Figure 1**

Cutting may have had lasting effects on house mouse habitat use at the Kellogg Farm. Figure 2 shows the morning trap success based on the total number of captures and total number of individuals captured in the alfalfa field before and after harvests during 1997 and 1998. During 1997, only one of 33 (0.03) individuals using the alfalfa field was recaptured in the field following a harvest. One male was not included in this proportion because it was captured after the final harvest date. A similar proportion (0.08;  $n = 1$  individual) was recaptured in the alfalfa field after a harvest during 1998.

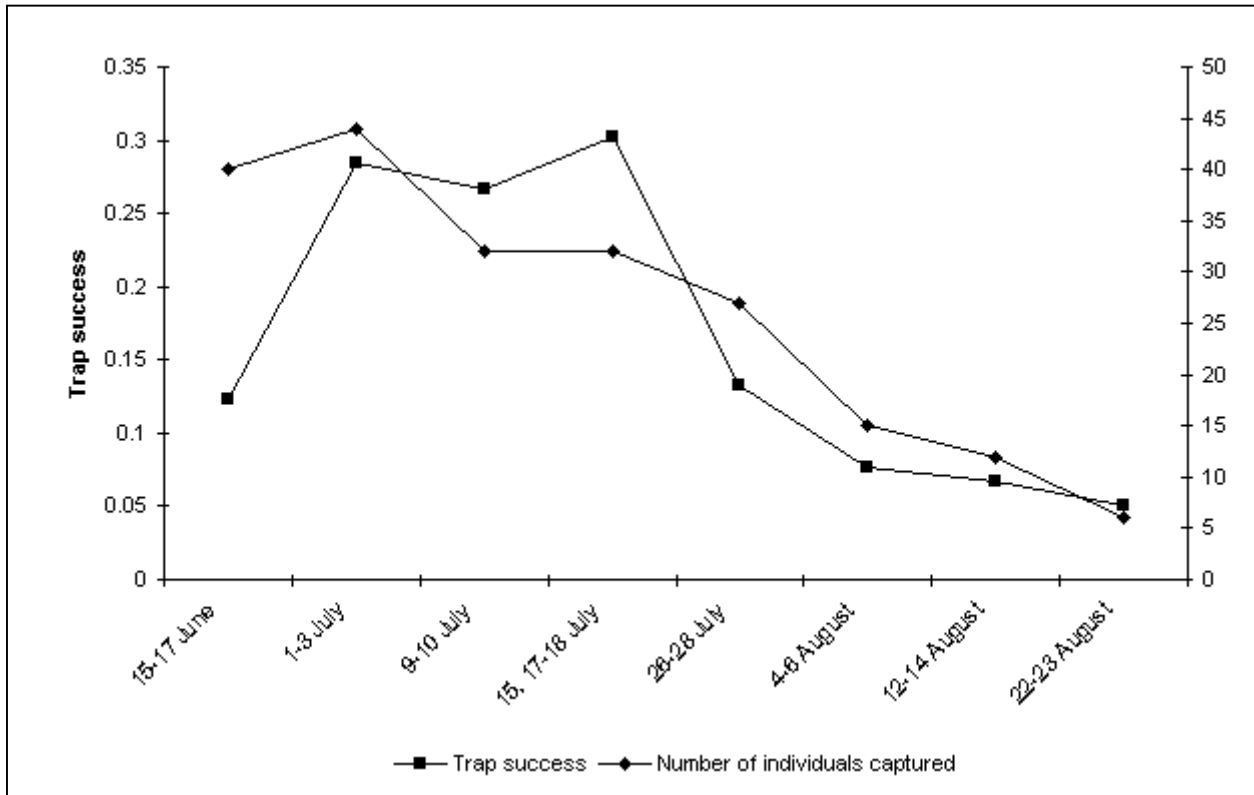
The sex ratio of individuals using the alfalfa field did not change through the summer. More females than males were captured in the alfalfa field during each period between harvests during 1997 and 1998. One male was captured in the field after the final harvest during 1997.



**Figure 2**

**1997 index of abundance**

During 1997, the minimum number of mice known to be alive (MNA) in the barn decreased through the summer (Figure 3). Although abundance estimates were not made during 1998 (due to trapping methods), trap success in the barn was not as high as it was during the early half of the 1997 summer.



**Figure 3**

### Concluding remarks

House mice showed a propensity to associate with the barn while periodically moving into the alfalfa field. House mice, particularly females, moved into the field as the alfalfa regenerated, suggesting that the alfalfa or something associated with the field provides a valuable resource. The removal of cover during harvests may effectively limit mice to within the barn (during both years, fewer mice used the fields following the second harvest), affecting barn population processes. Resources within the barn may become limiting as mice move back into the barn and are unable to access resources in the field during the weeks following each harvest. Manipulative studies are needed to determine if the decrease in population size within the barn during 1997 is common in barns next to repeatedly harvested fields. Are barns next to disturbed fields similar to islands of high quality habitat or are mice able to move between barns despite heterogeneity in adjacent fields? Can the repeated mowing of grass next to barns on farmsteads effectively limit mice to within barns? Answers to these questions may help us to more effectively manage rodents in the agricultural landscape, potentially reducing damage to crops and stored foodstuffs.

### Acknowledgements

I thank the many field assistants who helped me during my study. I am grateful to Jim Bronson and the rest of the Kellogg Farm staff for allowing me to conduct my work there and for planning alfalfa harvests around my trapping schedule. The entire staff was very patient and helpful. I thank my advisor, R.W. Hill, for his advice and support throughout the study. I also thank G. Mittelbach for serving as my KBS advisor. D. Straney and S. Winterstein provided valuable advice on methodology and statistics. K. Holekamp and S. Nunes provided the telemetry equipment. My research was supported by two KBS summer RTG fellowships, a grant from the American Society of Mammalogists, the Department of Zoology, the Ecology, Evolutionary Biology and Behavior Program and KBS Lauff scholarships. Finally, I thank the men of the Burgner house for putting up with traps, radio-telemetry equipment, peanut butter, straw and daily mouse stories.

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<sup>1</sup> One female that died during capture was not included in the analysis.

## ***Evaluation Of Alfalfa And Birdsfoot Trefoil Under Intensive Rotational Grazing***

Martha Tomecek, and Rich Leep

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### **Justification and Objectives**

Farmers' interest in managed intensive rotational grazing (MiG) is due to its lower input costs, lower capital investments, reduced labor requirements, improved quality of family life and reduced environmental impacts. Our grazing study attempted to address some of the biological questions associated with MiG. This study's objective was to evaluate the performance of pastures planted with alfalfa and birdsfoot trefoil while being grazed by Holstein steers.

### **Methods and Procedures**

Holstein steers were grazed in the legume+grass pastures for the fourth year. The two legumes being evaluated are Alfagraze alfalfa and Norcen birdsfoot trefoil interseeded with Citadel perennial ryegrass. Grazing began when the forage was approximately six inches tall. Additional steers referred to as grazers, were placed in the pastures to keep the forage evenly grazed. They were removed after the spring flush of growth. No supplementation other than minerals were given. Grazer and tester steers were weighed each of two consecutive days when there was insufficient forage to support them. The experimental design is a randomized complete block with three replications.

### **Tester Steer Performance**

	<b>Alfalfa+Grass</b>	<b>Birdsfoot Trefoil+Grass</b>
Initial wt (lb)	514	512
Grazing Days	103	103
Stocking Rate (hd/acre)	1.5	1.4
ADG (lb)	2.3	2.5
total gain/steer (lb)	233	259
total gain/acre (lb)	350	318
deaths due to bloat	0	0
deaths due to pneumonia	0	2

## Forage Values

	Alfalfa+Grass	Birdsfoot Trefoil+Grass
Apr-May Grazing Period (lb/A)	2762.9	1761.3
May-Jun Grazing Period (lb/A)	4983.2	4101.9
Jul-Aug Grazing Period (lb/A)	3592.4	3109.6
Aug-Sep Grazing Period (lb/A)	2231.5	3338.7
Total for Season (tons/A)	6.78	6.16
Stem counts (alfalfa or trefoil) stems/sq ft.	19	10
% alfalfa or birdsfoot trefoil in sward	9	16
% clover in sward	3	3
% grass in sward	86	75
% other in sward	2	6

## Precipitation data

Month	30 year avg (inches)	1998 (inches)
January	1.8	3.6
February	1.5	2.1
March	1.9	4.0
April	3.5	4.7
May	3.1	1.4
June	4.1	2.5
July	3.4	4.5
August	3.5	1.9
September	3.0	1.8
October	2.8	2.8
November	2.8	1.8
December	2.4	1.0
Yearly Total	34	32

## Discussion

The grazing season for legume pastures in southwestern Michigan is estimated to be 150 days or until there is insufficient forage to support animals. In 1998, the months of May, June, August and September had less than half the normal precipitation. Steers were removed for most of July and fed corn silage and/or alfalfa hay in nearby pastures. They were placed back in the legume+grass pastures in August but were removed by the first of September once again due to lack of sufficient forage. The grazing season ended with a total of 103 grazing days.

Individual steer performance, as measured by average daily gain and total gain per steer, was greater for those steers in the birdsfoot trefoil+grass pastures. However, since stocking rates are higher in the alfalfa+grass pastures, these pastures produced more gain per acre. There were no deaths due to bloat, which wasn't any concern this year due to the high grass component in the pastures. Two steers died of

pneumonia, probably infected on their truck ride to Michigan from one of the southern states where they originated.

The alfalfa+grass pastures consistently had higher yields throughout the grazing periods with the exception of the last period when trefoil+grass pastures had more forage. This reflected the seasonal yields where alfalfa+grass pastures produced more forage than birdsfoot trefoil+grass pastures (6.8 T/A and 6.2 T/A, respectively). The high percentage of grass (86%) in the alfalfa+grass pastures probably contributes to the higher yields. The trefoil+grass pastures have a higher 'other' component than the alfalfa+grass pastures but clover content is the same for both pastures. Alfalfa and birdsfoot trefoil plants continue to decline in numbers. Stem counts for alfalfa in the alfalfa+grass pastures was 19 stem/ft<sup>2</sup>. In the birdsfoot trefoil+grass pastures, stem counts for birdsfoot trefoil were 10 stems/ft<sup>2</sup>.

After four years of grazing, our research has found that dry matter production and herd gain per acre are greater on the alfalfa+grass than on birdsfoot trefoil+grass pastures. Citadel perennial ryegrass continues to persist with little winter kill and by reseeding. The reduction of the legume component in these pastures continues. Increasing their percentage of the forage sward will be addressed in the future. We anticipate grazing the replacement dairy heifers from the Kellogg Dairy for the 1999 season.

### **Funding**

Michigan Agricultural Experiment Station

USDA Sustainable Agriculture Special Grant: Management Systems for Sustainability Integrating Soil, Plants and Steers.

Michigan Department of Agriculture Groundwater Stewardship Program

### ***Kellogg Farm Cropping Overview***

Jim Bronson, Kellogg Farm Manager

The following tables consist of soil, manure and crop yield data as well as a listing of research projects that were supported by the use of land assigned to the Kellogg Dairy Center for the 1998 calendar year.

The data reported here have been published in much the same format in previous Kellogg Farm reports. It provides an historical reference for the farm managers and researchers who may be interested in examining long-term trends or using real farm data.

Crop yields were calculated primarily from actual truck scale weights of each load of harvested commodity. All yields are corrected to standard agronomic moisture contents based on moisture testers for grains and either Koster Tester or microwaved samples for forages. For the first time in 1998, an Ag Leader yield monitor system was used during corn and soybean harvest. Good data from the Ag Leader system is available for the corn crop. Some soybean yields are missing due primarily to the fact that deer damage lowered yields so much that a reliable reading by the Ag Leader system was not possible.

Manure data included in this report is all derived from each load being weighed on a truck scale prior to application and coded for manure product and field destination.

Tables showing fertilizer and planting data are adapted from the MSU Nutrient Management computer program developed by Dr. Lee Jacobs, Bruce MacKellar and Sven Bohm.

Table 1. Manure production by product number (and product description) for the calendar year 1998.

<b>Manure Product</b>	<b>Product Description</b>	<b>Total Tons Produced</b>
81	Heifer Barn	395.79
82	Beef Barn	7.54
83	Spoiled Corn Silage	145.92
84	Spoiled Haylage	42.20
85	Free Stall Barn	2786.40
86	Separated Solids	13.82
87	Maternity, Calf Hutches	45.02
88	Mixture	341.50
89	Composted Leaves + Manure	26.06

Table 2. Total monthly manure production by product identification number and month.

<b>Month</b>	<b>Manure Product</b>	<b>Total Weight in Pounds</b>	<b>Total Wet Tons Produced</b>
January	81	53,980	26.99
January	82	15,080	7.54
January	84	11,000	5.50
January	85	603,860	301.93
January	88	83,620	41.81
February	81	44,000	22.00
February	84	23,140	11.57
February	85	467,520	233.76
February	88	91,800	45.90
March	81	26,220	13.11
March	84	11,380	5.69
March	85	573,440	286.72
March	88	90,700	45.34
March	89	52,120	26.06
April	81	36,080	18.04
April	83	97,520	48.76
April	85	436,240	218.12
April	87	14,400	7.20
April	88	144,520	72.26
May	81	25,400	12.70

May	85	300,180	150.09
May	88	64,080	32.04
June	84	10,520	5.26
June	85	465,840	232.92
June	87	32,380	16.19
June	88	24,380	12.19
July	81	8,000	4.00
July	83	11,760	5.88
July	84	19,620	9.81
July	85	484,520	242.26
July	87	29,020	14.51
July	88	16,040	8.02
August	81	13,060	6.53
August	83	10,440	5.22
August	84	8,740	4.37
August	85	389,000	194.50
August	87	7,520	3.76
August	88	73,940	36.97
September	81	186,960	93.48
September	83	51,160	25.58
September	85	477,140	283.57
October	81	189,540	94.77
October	83	79,940	39.97
October	85	385,090	192.55
October	88	16,230	8.12
November	81	151,340	75.67
November	83	41,020	20.51
November	85	517,400	258.70
November	86	27,640	13.82
December	81	57,000	28.50
December	85	472,560	236.28
December	87	6,720	3.36
December	88	77,680	38.84

Table 3. Planting Information for 1998

Field	Date	Acres	Crop Planted	Variety	Rate	Units
72	04/06/1998	11.1	Alfalfa-Seeding	DEKALB DK121HG	18.9	lb seed/acre
74	04/06/1998	11.4	Alfalfa-Seeding	DEKALB DK121HG	18.9	lb seed/acre
94	03/25/1998	20.3	Clover	RED MAMMOTH	12.0	lb seed/acre
98-4	03/25/1998	4.1	Clover	RED MAMMOTH	12.0	lb seed/acre
T16	03/26/1998	13.0	Oats	IDA WHITE	69.0	lb seed/acre
LA63-1	04/20/1998	11.9	Oats	IDA WHITE	94.0	lb seed/acre
LA63-2	04/20/1998	11.8	Oats	IDA WHITE	94.0	lb seed/acre
LA63-3	04/20/1998	11.8	Oats	IDA WHITE	94.0	lb seed/acre
79-1	04/24/1998	11.5	Corn-Silage	CARGILL 6208FQ	23000	seeds/acre
79-5	04/24/1998	9.3	Corn-Silage	CARGILL 6208FQ	23500	seeds/acre
79-6	04/24/1998	9.0	Corn-Silage	CARGILL 6208FQ	23500	seeds/acre
98-1	04/30/1998	5.8	Corn-Silage	CARGILL 6208FQ	22000	seeds/acre
98-2	04/30/1998	23.4	Corn-Silage	CARGILL 6208FQ	30500	seeds/acre
98-3	05/06/1998	26.0	Corn-Silage	CARGILL F657 (BMR)	31000	seeds/acre
80	05/06/1998	6.7	Corn-Silage	CARGILL 6208FQ	21500	seeds/acre
80	05/06/98	6.8	Corn-Silage	CARGILL F657 (BMR)	21500	seeds/acre
38-1	05/06/1998	6.2	Corn-Silage	CARGILL 6208FQ	21000	seeds/acre
38-2	05/06/1998	10.0	Corn-Silage	CARGILL F657 (BMR)	21000	seeds/acre
24	05/06/1998	5.9	Corn-Silage	CARGILL 6208FQ	22000	seeds/acre
23-9	05/06/1998	5.0	Corn-Silage	CARGILL 6208FQ	22000	seeds/acre
23-9	05/06/1998	7.6	Corn-Silage	CARGILL F657 (BMR)	22,000	seeds/acre

T17-1	05/06/1998	13.3	Corn-Silage	CARGILL 6208FQ	21000	seeds/acre
T17-2	05/06/1998	10.0	Corn-Silage	CARGILL F657 (BMR)	21,000	seeds/acre
68	05/06/1998	7.3	Corn-Silage	CARGILL 6208FQ	22000	seeds/acre
68	05/06/1998	6.0	Corn-Silage	CARGILL F657 (BMR)	22000	seeds/acre
T11-1	05/04/1998	5.0	Corn-Grain	LG SEEDS LG2499	22000	seeds/acre
LA4-1	05/15/1998	7.2	Corn-Grain	DEKALB 561SR	23500	seeds/acre
LA4-2	05/15/1998	10.0	Corn-Grain	DEKALB 561SR	23500	seeds/acre
LA4-3	05/15/1998	15.0	Corn-Grain	DEKALB 561SR	23500	seeds/acre
LA4-4	05/15/1998	10.0	Corn-Grain	DEKALB 493BT	23500	seeds/acre
LA5-1	05/15/1998	10.0	Corn-Grain	DEKALB 493SR	22000	seeds/acre
LA5-2	05/15/1998	14.0	Corn-Grain	DEKALB 561SR	23000	seeds/acre
LA7-1	05/13/1998	15.3	Corn-Grain	DEKALB 493	22000	seeds/acre
LA7-2	05/13/1998	10.0	Corn-Grain	DEKALB 493	22000	seeds/acre
LA7-3	05/13/1998	9.3	Corn-Grain	DEKALB 493	22000	seeds/acre
LA62-1	05/12/1998	10.2	Corn-Grain	LGSEEDS LG2499	22000	seeds/acre
LA62-2	05/12/1998	10.2	Corn-Grain	LGSEEDS LG2499	22000	seeds/acre
LA62-3	05/12/1998	8.8	Corn-Grain	LGSEEDS LG2499	22000	seeds/acre
LA64	05/12/1998	12.0	Corn-Grain	DEKALB 493RR	22000	seeds/acre
LA64	05/13/1998	2.2	Corn-Grain	LG SEEDS LG2499	22000	seeds/acre
LA65-1	05/12/1998	9.7	Corn-Grain	DEKALB 493RR	22000	seeds/acre
LA65-2	05/12/1998	9.8	Corn-Grain	DEKALB 493RR	22000	seeds/acre
90-2	05/12/1998	3.1	Corn-Grain	DEKALB 493RR	22000	seeds/acre
87	05/11/1998	13.3	Corn-Grain	DEKALB 442	22000	seeds/acre

T14-1	05/11/1998	8.0	Corn-Grain	DEKALB 442	22000	seeds/acre
T14-2	05/11/1998	8.0	Corn-Grain	DEKALB 442	22000	seeds/acre
T15-1	05/11/1998	11.6	Corn-Grain	PIONEER 36G32 BT	22000	seeds/acre
T15-2	05/11/1998	11.5	Corn-Grain	DEKALB 493BT	22000	seeds/acre
T15-3	05/11/1998	11.5	Corn-Grain	DEKALB 493BT	22000	seeds/acre
T12-1	05/08/1998	9.4	Corn-Grain	DEKALB 493BT	22000	seeds/acre
T12-2	05/08/1998	9.4	Corn-Grain	DEKALB 493BT	22000	seeds/acre
T12-3	05/08/1998	9.3	Corn-Grain	DEKALB 493BT	22000	seeds/acre
40	05/08/1998	14.7	Corn-Grain	DEKALB 546	22500	seeds/acre
52	05/08/1998	17.0	Corn-Silage	CARGILL 6208FQ	22500	seeds/acre
T11-1	05/11/1998	9.3	Corn-Grain	LG SEEDS LG2499	22000	seeds/acre
T11-2	05/11/1998	9.2	Corn-Grain	LG SEEDS LG249	22000	seeds/acre
LA6-1	05/26/1998	8.9	Soybeans	DEKALB CX-266RR	172000	seeds/acre
LA6-2	05/26/1998	8.8	Soybeans	DEKALB CX-266RR	172000	seeds/acre
LA3	05/27/1998	8.0	Soybeans	DEKALB CX-232	155000	seeds/acre
LA61	05/27/1998	17.2	Soybeans	DEKALB CX-232	153000	seeds/acre
LA2	05/27/1998	12.1	Soybeans	DEKALB CX-232	155000	seeds/acre
LA1	05/28/1998	13.5	Soybeans	DEKALB CX-232	158000	seeds/acre
LA9	05/28/1998	12.5	Soybeans	DEKALB CX-232	158000	seeds/acre
LA10	05/28/1998	7.7	Soybeans	DEKALB CX-232	155000	seeds/acre
30-2	05/07/1998	7.2	Corn-Silage	CARGILL F6208FQ	22500	seeds/acre
30-2	05/07/1998	7.2	Corn-Silage	CARGILL F657; BMR	22500	seeds/acre
36	05/07/1998	6.0	Corn-Silage	CARGILL 6208FQ	22500	seeds/acre

36	05/07/1998	6.0	Corn-Silage	CARGILL F657 (BMR)	22500	seeds/acre
71	08/12/1998	16.6	Alfalfa-Seeding	DEKALB 127	19.0	lb seed/acre
30-1	08/14/1998	15.0	Alfalfa-Seeding	DKLB/CMARK 'RESISTAR'	20.0	lb seed/acre
82-1	08/12/1998	8.0	Oats	Cover Crop	80.0	lb seed/acre
82-2	08/12/1998	4.0	Oats	Cover Crop	80.0	lb seed/acr
T16	08/19/1998	13.0	Oats	Cover Crop	80.0	lb seed/acre
24	09/03/1998	5.9	Oats	Cover Crop	60.0	lb seed/acre
68	09/03/1998	13.6	Oats	Cover Crop	60.0	seeds/acre
38-2	09/03/1998	12.0	Oats	Cover Crop	60.0	seeds/acre
87	10/11/1998	13.3	Wheat	PIONEER 2552	195.0	lb seed/acre
LA1	10/12/1998	13.5	Wheat	PIONEER 2552	150.0	lb seed/acre
LA10	10/12/1998	7.7	Wheat	PIONEER 2552	150.0	lb seed/acre
68	09/20/1998	13.6	Oats	Cover Crop	90.0	lb seed/acre
38-2	09/20/1998	8.0	Oats	Cover Crop	90.0	lb seed/acre
23-9	09/20/1998	18.4	Oats	Cover Crop	90.0	lb seed/acre
82-1	08/22/1998	8.0	Oats	Cover Crop	90.0	lb seed/acre
82-2	08/20/1998	4.0	Oats	Cover Crop	90.0	lb seed/acre
36	09/25/1998	13.5	Rye	Cover Crop	50.0	lb seed/acre
98-4	09/22/1998	4.1	Rye for seed	WHEELER	55.0	lb seed/acre
LA3	10/25/1998	8.0	Rye	Cover Crop	65.0	lb seed/acre
LA2	10/10/1998	12.1	Rye	Cover Crop	65.0	lb seed/acre
LA4-1	10/29/1998	7.2	Rye	Cover Crop	65.0	lb seed/acre

LA4-2	10/29/1998	10.0	Rye	Cover Crop	65.0	lb seed/acre
LA4-3	10/29/1998	15.0	Rye	Cover Crop	65.0	lb seed/acre
LA4-4	10/29/1998	10.0	Rye	Cover Crop	65.0	lb seed/acre
LA5-1	10/25/1998	10.0	Rye	Cover Crop	65.0	lb seed/acre
LA5-2	10/25/1998	14.0	Rye	Cover Crop	65.0	lb seed/acre
LA7-1	11/01/1998	15.3	Rye	Cover Crop	65.0	lb seed/acre
LA7-2	11/01/1998	10.0	Rye	Cover Crop	65.0	lb seed/acre
LA7-3	11/01/1998	9.3	Rye	Cover Crop	65.0	lb seed/acre
LA62-1	10/15/1998	10.2	Rye	Cover Crop	65.0	lb seed/acre
LA62-2	10/15/1998	10.2	Rye	Cover Crop	65.0	lb seed/acre
LA62-3	10/15/1998	8.8	Rye	Cover Crop	65.0	lb seed/acre

Table 4. Fertilizer and Lime Applications in 1998

FIELD	DATE	PRODUCT	RATE	METHOD	N	P2O5	K2O	LIME TYPE
87	04/10/1998	0-0-60	140	Broadcast	0	0	84	
80	04/10/1998	0-0-60	100	Broadcast	0	0	60	
82-1	03/24/1998	Urea	90	Broadcast	41	0	0	
82-2	03/24/1998	Urea	90	Broadcast	41	0	0	
94-0	03/24/1998	Urea	125	Broadcast	58	0	0	
83	04/15/1998	0-0-60	280	Broadcast	0	0	168	
97	04/15/1998	0-0-60	360	Broadcast	0	0	216	
79-4	04/15/1998	0-0-60	360	Broadcast	0	0	216	
79-3	04/15/1998	0-0-60	170	Broadcast	0	0	102	

91-1	04/15/1998	0-0-60	260	Broadcast	0	0	156	
93	04/15/1998	0-0-60	260	Broadcast	0	0	156	
50-2	04/15/1998	0-0-60	145	Broadcast	0	0	87	
T13-1	04/16/1998	0-0-60	140	Broadcast	0	0	84	
80	04/16/1998	0-0-60	100	Broadcast	0	0	60	
87	04/16/1998	0-0-60	160	Broadcast	0	0	96	
T14-1	04/16/1998	0-0-60	100	Broadcast	0	0	60	
T14-2	04/16/1998	0-0-60	100	Broadcast	0	0	60	
T12-1	04/16/1998	0-0-60	100	Broadcast	0	0	60	
T12-2	04/16/1998	0-0-60	100	Broadcast	0	0	60	
T12-3	04/16/1998	0-0-60	100	Broadcast	0	0	60	
LA5-1	04/16/1998	0-0-60	100	Broadcast	0	0	60	
LA5-2	04/16/1998	0-0-60	100	Broadcast	0	0	60	
LA2	04/16/1998	0-0-60	130	Broadcast	0	0	78	
LA1	04/20/1998	0-0-60	140	Broadcast	0	0	84	
LA3	04/20/1998	0-0-60	125	Broadcast	0	0	75	
LA4-1	04/20/1998	0-0-60	100	Broadcast	0	0	60	
LA4-2	04/20/1998	0-0-60	100	Broadcast	0	0	60	
LA4-3	04/20/1998	0-0-60	100	Broadcast	0	0	60	
LA4-4	04/20/1998	0-0-60	100	Broadcast	0	0	60	
LA6-2	04/20/1998	0-0-60	125	Broadcast	0	0	75	
LA62-1	04/20/1998	0-0-60	100	Broadcast	0	0	60	
LA62-2	04/20/1998	0-0-60	100	Broadcast	0	0	60	

LA62-3	04/20/1998	0-0-60	100	Broadcast	0	0	60	
LA64	04/20/1998	0-0-60	100	Broadcast	0	0	60	
LA65-1	04/20/1998	0-0-60	100	Broadcast	0	0	60	
LA65-2	04/20/1998	0-0-60	100	Broadcast	0	0	60	
23-9	04/20/1998	Anhydrous	110	Banded	90	0	0	
24	04/20/1998	Anhydrous	110	Banded	90	0	0	
38-1	04/20/1998	Anhydrous	50	Banded	41	0	0	
38-2	04/20/1998	Anhydrous	50	Banded	41	0	0	
52	04/20/1998	Anhydrous	110	Banded	90	0	0	
79-1	04/20/1998	Anhydrous	85	Banded	70	0	0	
79-5	04/20/1998	Anhydrous	85	Banded	70	0	0	
79-6	04/20/1998	Anhydrous	85	Banded	70	0	0	
80	04/20/1998	Anhydrous	40	Banded	33	0	0	
87	04/21/1998	Anhydrous	60	Banded	49	0	0	
90-2	04/20/1998	Anhydrous	155	Banded	127	0	0	
98-1	04/20/1998	Anhydrous	40	Banded	33	0	0	
98-2	04/20/1998	Anhydrous	40	Banded	33	0	0	
98-3	04/20/1998	Anhydrous	40	Banded	33	0	0	
T11-1	04/20/1998	Anhydrous	55	Banded	45	0	0	
T11-2	04/20/1998	Anhydrous	55	Banded	45	0	0	
T12-1	04/22/1998	Anhydrous	135	Banded	111	0	0	
T12-2	04/22/1998	Anhydrous	135	Banded	111	0	0	
T12-3	04/22/1998	Anhydrous	135	Banded	111	0	0	

T14-1	04/22/1998	Anhydrous	135	Banded	111	0	0	
T14-2	04/22/1998	Anhydrous	135	Banded	111	0	0	
T15-1	04/22/1998	Anhydrous	40	Banded	33	0	0	
T15-2	04/22/1998	Anhydrous	40	Banded	33	0	0	
T15-3	04/22/1998	Anhydrous	40	Banded	33	0	0	
T17-1	04/22/1998	Anhydrous	70	Banded	57	0	0	
T17-2	04/22/1998	Anhydrous	70	Banded	57	0	0	
30-2	04/22/1998	Anhydrous	50	Banded	41	0	0	
36	04/22/1998	Anhydrous	50	Banded	41	0	0	
79-1	04/24/1998	10-50-0	25	Banded	3	13	0	
79-5	04/24/1998	10-50-0	100	Banded	10	50	0	
79-6	04/24/1998	10-50-0	30	Banded	3	15	0	
LA64	04/24/1998	Anhydrous	150	Banded	123	0	0	
LA65-1	04/24/1998	Anhydrous	150	Banded	123	0	0	
LA65-2	04/24/1998	Anhydrous	150	Banded	123	0	0	
38-2	04/24/1998	0-0-60	110	Broadcast	0	0	66	
71	04/28/1998	0-45-0	123	Broadcast	0	55	0	
LA62-1	04/28/1998	Anhydrous	150	Banded	123	0	0	
LA62-2	04/28/1998	Anhydrous	150	Banded	123	0	0	
LA62-3	04/28/1998	Anhydrous	150	Banded	123	0	0	
LA5-1	04/28/1998	Anhydrous	60	Banded	49	0	0	
LA5-2	04/28/1998	Anhydrous	60	Banded	49	0	0	
LA7-1	04/28/1998	Anhydrous	145	Banded	119	0	0	

LA7-2	04/29/1998	Anhydrous	145	Banded	119	0	0	
LA7-3	04/29/1998	Anhydrous	145	Banded	119	0	0	
LA4-1	04/29/1998	Anhydrous	135	Banded	111	0	0	
LA4-2	04/29/1998	Anhydrous	135	Banded	111	0	0	
LA4-3	04/29/1998	Anhydrous	135	Banded	111	0	0	
LA4-4	04/30/1998	Anhydrous	135	Banded	111	0	0	
68	04/30/1998	Anhydrous	50	Banded	41	0	0	
98-1	04/30/1998	10-31-0 + S	6	Banded	7	20	0	
98-2	04/30/1998	10-31-0 + S	3	Banded	3	10	0	
98-3	05/06/1998	10-31-0 + S	5	Banded	6	17	0	
T15-3	04/01/1998	Lime	1	Broadcast	0	0	0	Dolomite
T17-2	04/01/1998	Lime	1	Broadcast	0	0	0	Dolomite
30-1	04/01/1998	Lime	1	Broadcast	0	0	0	Dolomite
40	04/01/1998	Lime	2	Broadcast	0	0	0	Dolomite
24	04/01/1998	Lime	2	Broadcast	0	0	0	Dolomite
72	04/01/1998	Lime	2	Broadcast	0	0	0	Dolomite
74-0	04/01/1998	Lime	3	Broadcast	0	0	0	Dolomite
79-1	04/01/1998	Lime	1	Broadcast	0	0	0	Dolomite
98-1	04/01/1998	Lime	1	Broadcast	0	0	0	Dolomite
98-2	04/01/1998	Lime	1	Broadcast	0	0	0	Dolomite
98-3	04/01/1998	Lime	1	Broadcast	0	0	0	Dolomite
LA1	04/01/1998	Lime	2	Broadcast	0	0	0	Dolomite
LA4-1	04/01/1998	Lime	1	Broadcast	0	0	0	Dolomite

LA4-2	04/01/1998	Lime	1	Broadcast	0	0	0	Dolomite
LA4-3	04/01/1998	Lime	1	Broadcast	0	0	0	Dolomite
LA4-4	04/01/1998	Lime	1	Broadcast	0	0	0	Dolomite
LA9	04/01/1998	Lime	1	Broadcast	0	0	0	Dolomite
LA10	04/01/1998	Lime	1	Broadcast	0	0	0	Dolomite
T16	05/05/1998	Urea	100	Broadcast	46	0	0	
80	05/06/1998	10-31-0 + S	5	Banded	6	17	0	
38-1	05/05/1998	10-31-0 + S	5	Banded	6	17	0	
38-2	05/06/1998	10-31-0 + S	5	Banded	6	17	0	
24	05/05/1998	10-31-0 + S	5	Banded	6	17	0	
T17-1	05/06/1998	10-31-0 + S	5	Banded	6	17	0	
T17-2	05/06/1998	10-31-0 + S	5	Banded	6	17	0	
30-2	05/06/1998	10-31-0 + S	5	Banded	6	17	0	
36	05/06/1998	10-31-0 + S	5	Banded	6	17	0	
68	05/06/1998	10-31-0 + S	5	Banded	6	17	0	
LA4-1	05/15/1998	10-31-0 + S	5	Banded	6	17	0	
LA4-2	05/15/1998	10-31-0 + S	5	Banded	6	17	0	
LA4-3	05/15/1998	10-31-0 + S	5	Banded	6	17	0	
LA4-4	05/15/1998	10-31-0 + S	5	Banded	6	17	0	
LA5-1	05/14/1998	10-31-0 + S	5	Banded	6	17	0	
LA5-2	05/14/1998	10-31-0 + S	5	Banded	6	17	0	
LA7-1	05/13/1998	10-31-0 + S	5	Banded	6	17	0	
LA7-2	05/13/1998	10-31-0 + S	5	Banded	6	17	0	

LA7-3	05/13/1998	10-31-0 + S	5	Banded	6	17	0	
LA62-1	05/12/1998	10-31-0 + S	5	Banded	6	17	0	
LA62-2	05/12/1998	10-31-0 + S	5	Banded	6	17	0	
LA62-3	05/12/1998	10-31-0 + S	5	Banded	6	17	0	
LA64	05/11/1998	10-31-0 + S	5	Banded	6	17	0	
LA65-1	05/11/1998	10-31-0 + S	5	Banded	6	17	0	
LA65-2	05/11/1998	10-31-0 + S	5	Banded	6	17	0	
90-2	05/12/1998	10-31-0 + S	5	Banded	6	17	0	
87	05/12/1998	10-31-0 + S	5	Banded	6	17	0	
T14-1	05/11/1998	10-31-0 + S	5	Banded	6	17	0	
T14-2	05/11/1998	10-31-0 + S	5	Banded	6	17	0	
T15-1	05/10/1998	10-31-0 + S	5	Banded	6	17	0	
T15-2	05/10/1998	10-31-0 + S	5	Banded	6	17	0	
T15-3	05/10/1998	10-31-0 + S	5	Banded	6	17	0	
T12-1	05/08/1998	10-31-0 + S	5	Banded	6	17	0	
T12-2	05/08/1998	10-31-0 + S	5	Banded	6	17	0	
T12-3	05/08/1998	10-31-0 + S	5	Banded	6	17	0	
40	05/08/1998	10-31-0 + S	5	Banded	6	17	0	
52	05/08/1998	10-31-0 + S	5	Banded	6	17	0	
LA6-1	05/26/1998	10-31-0 + S	5	Banded	6	17	0	
LA6-2	05/26/1900	10-31-0 + S	5	Banded	6	17	0	
LA63-1	05/08/1998	Urea	165	Broadcast	76	0	0	
LA63-2	05/08/1998	Urea	220	Broadcast	101	0	0	

LA63-3	05/08/1998	Urea	195	Broadcast	90	0	0	
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Table 5. This was the first year we used a grain yield monitor system to map each corn field. The table lists total "dry" bushels (corrected to 15.5 percent moisture) as derived from truck scale weights and the Ag Leader system, grain moisture contents as determined by a Burrows Moisture computer and the Ag Leader system, and acres harvested as determined by traditional acreage values for each field and the Ag Leader system. Bushels/acre yield data was then calculated using the two separate data sets.

Field	Total Dry_Bushels		Percent Moisture		Acres Harvested		Bushels/Acre	
	Scale	AgL.	Tester	AgL.	Tradition	AgL.	Scale	AgL.
LA4	4748	4308	25.7	22.5	52.5	50.3	90.5	95.5
LA5	2318	2386	18.2	19.9	24.0	22.7	96.6	105.0
LA7	2792	2550	16.6	17.8	34.6	33.4	80.7	76.4
T11	1021	1006	25.7	26.8	13.5	13.5	75.6	74.5
T12	2239	1956	17.2	19.0	28.1	26.1	79.7	75.0
T14	1549	1040	19.7	20.3	16.0	17.0	96.8	61.4
T15	3121	3019	18.9	21.4	34.6	33.0	90.2	91.5
T17	932	1173	28.4	28.0	19.5	19.5	47.8	60.3
40	1613	1593	26.3	22.9	14.7	14.6	109.7	109.0
52	1463	1444	30.8	30.9	17.0	13.9	86.0	103.9
LA62	2859	3053	28.8	28.1	29.2	26.9	97.9	113.6
LA64	1358	1508	17.7	18.0	14.2	13.7	95.6	109.8
LA65	2099	1643	20.0	21.2	19.5	18.8	107.6	87.6
79-1	695	625	27.3	29.1	11.5	11.1	60.4	56.1
79/5,6	820	755	27.3	29.5	18.3	19.0	44.8	39.7
80	576	559	30.5	30.5	6.1	6.1	94.4	91.2
90-2	230	215	17.2	19.6	3.1	2.9	74.3	73.8
98-1	501	496	30.8	29.6	5.8	5.1	86.3	97.2
98-2	906	930	33.5	33.6	5.3	5.3	170.9	174.9

Table 6. 1998 soybean yields. These yield data are derived solely from yield monitor data. During this year's soybean harvest the Dairy Center truck scale was out of order and so no actual weight data are available. A weigh wagon was used to develop a calibration curve for the monitor. Severe yield losses from deer damage occurred in fields LA1, LA3, LA9 and LA10.

Field	Acres	Grain Moisture	Bushels at 13.0% Moisture	Bu/Ac
LA1	13.2	15.1	170.0	12.9
LA2	11.3	15.0	345.9	30.6
LA3	7.7	13.6	110.5	14.3
LA6	19.6	14.7	810.7	41.3
LA9	NA	NA	NA	NA
LA10	NA	NA	NA	NA

Table 7. 1998 wheat yields. Yield data derived from truck scale weights and moisture tester data and corrected to 13 percent grain moisture content.

Field	Bu/Acre @13% Moisture
71	38.7
82	33.4
94	57.4

Table 8. Alfalfa hay yields for 1998. All haylage data corrected to 15 percent moisture. Note that data for one cutting in Field 22 are missing. That field was cut four times but third cutting data are unavailable.

Field	Total Tons Harvested	Tons Harvested at 15% Moisture	Number of cuts	Yield in Tons/Acre
13	41.9	18.0	2	2.33
20	131.9	31.4	3	4.20
21	132.0	33.4	4	3.95
22	110.9	33.6	3**	3.30
23-7	3.4	4.3	1	0.80
41	4.3	4.5	2	0.94
50-8	81.4	37.3	3	2.18
79/2,3,4	82.5	27.6	3	2.99
83	46.3	14.9	3	3.11
85	10.1	3.3	3	3.06
91	16.8	8.2	2	2.05

93	43.5	14.9	3	2.92
97	27.9	13.7	2	2.04

Table 9. Corn silage yield data corrected to 65 percent moisture content. Moisture content for fields T11 and 87 is estimated. Silage from these two fields was quite dry at harvest and was stored separately from other silage.

Field	Acres	Researcher	Abbreviate Study Title
T17	20.3	Dr. Mike Allen, Animal Sci.	BMR vs. Regular Corn Silage Trial
23-9/24	18.5	Dr. Mike Allen, Animal Sci.	BMR vs. Regular Corn Silage Trial
30/36	26.4	Dr. Mike Allen, Animal Sci.	BMR vs. Regular Corn Silage Trial
38	18.0	Dr. Mike Allen, Animal Sci.	BMR vs. Regular Corn Silage Trial
52	17.0	Dr. Mike Allen, Animal Sci.	BMR vs. Regular Corn Silage Trial
68	13.6	Dr. Mike Allen, Animal Sci.	BMR vs. Regular Corn Silage Trial
79/1,5,6	29.8	Dr. Mike Allen, Animal Sci.	BMR vs. Regular Corn Silage Trial
80	13.5	Dr. Mike Allen, Animal Sci.	BMR vs. Regular Corn Silage Trial
98/2,3	49.4	Dr. Mike Allen, Animal Sci.	BMR vs. Regular Corn Silage Trial
38 (West side)	2.0	Dr. Jim Kells, Crops and Soils	Post Emergence Herbicide Trial
50	5.0 (approx)	Loren Hayes, Zoology	House Mouse Habitat Use and Mowing in Agri. Landscape

### **1998 Kellogg Dairy Overview**

Rob Ashley, Dairy Manager

The major study conducted at the Kellogg Dairy in 1998 looked at the effect of feeding Brown Midrib corn silage on lactational performance of dairy cows. This experiment involved 100 cows for their complete lactation. The trial is expected to conclude in November 1999.

The Meadows program continued to examine the effects of diet with negative cation-anion difference on the health and performance of lactating dairy cattle. Kellogg Farm is collaborating with the Pharmacia-Upjohn Company in determining the clinical efficacy of ceftiofur administration for the treatment of acute Gram-Negative mastitis in dairy cattle. The long-term grazing study concluded year four. Kellogg Farm continues to supply labor and data collection support.

Table 1. 1998 Kellogg Farm milk production per month.

Month	Number of Cows Milking	Number of Cows Dry	Average Daily Production	Total Production
January	140	16	73.2 lbs.	266,416 lbs.
February	136	9	68.8 lbs.	247,347 lbs.
March	135	6	63.5 lbs.	254,776 lbs.
April	134	15	68.1 lbs.	245,682 lbs.
May	130	22	69.2 lbs.	240,826 lbs.
June	138	20	67.4 lbs.	228,867 lbs.
July	144	15	65.5 lbs.	252,064 lbs.
August	137	15	67.7 lbs.	247,066 lbs.
September	141	19	61.4 lbs.	234,039 lbs.
October	139	17	61.8 lbs.	244,331 lbs.
November	135	13	67.4 lbs.	239,222 lbs.
December	136	10	61.9 lbs.	256,585 lbs.
<b>1998 PRODUCTION GRAND TOTAL:</b>				2,957,221 lbs.

Information on number of cows milking, cows dry, and average daily production is from monthly DHIA test sheets. Total production information is from Michigan Milk Producers Association (MMPA).

Table 2. 1998 monthly counts for raw bacteria, pre-incubated bacteria counts and somatic cell counts. Also listed is the total dollar value of payment premiums received.

Month	Raw Bacteria	Preincubated Bacteria	Somatic Cell	Value
January	1,000	4,000	206,000	\$266.42
February	3,000	100,000	166,000	371.02
March	3,000	2,000	153,000	509.56
April	8,000	6,000	178,000	491.36
May	4,000	10,000	186,000	481.66
June	12,000	-----	204,000	0
July	35,000	36,000	253,000	0
August	2,000	6,000	222,000	247.07
September	290,000	16,000	280,000	-234.04
October	3,000	16,000	325,000	244.33
November	5,000	19,000	221,000	239.22
December	1,000	12,000	181,000	513.18
<b>1998 PREMIUM PAYMENT TOTAL</b>				\$3,130.11

Table 3. Number of female calves born in 1998.

<b>62 Female Calves Born in 1998*</b>			
January	3	July	19**
February	1	August	4
March	2	September	6
April	0	October	8
May	5	November	3
June	10	December	1

\* Seven died within the year.

\*\* Seven heifers purchased from the MSU Campus Dairy Farm

### **1998 Kellogg Farm Tour, Volunteer And Staff Information**

Patty Foldesi, Kellogg Farm Secretary

As part of its mission in outreach and education, Kellogg Dairy hosts many visitors during the year. Most of these guests are casual visitors or school children who want to experience a modern dairy farm. The non-agricultural audience has two tour options for visiting the Dairy: the self-guided trail or the volunteer-guided group tour. The self-guided trail brochure offers suggested tour route and general information. The volunteer-guided tour covers the same points of interest, along with additional information the guides learn during an orientation and training process.

There is no record of the number of self-guided visitors that tour the Dairy. The number that participate in volunteer-led tours and pre-arranged, self-guided group tours are described in Table 1.

Kellogg Dairy volunteers are invaluable. Whether explaining the manure composting process to a sixth grader or encouraging a preschooler to pet a 1,200 pound cow, the volunteers are a tremendous asset. The volunteers are listed in Table 2. Thanks to Barbara Baker, KBS Volunteer Coordinator, for coordinating tour guides and providing tour attendance numbers.

Numerous tour requests are received from special interest or agricultural groups. The Kellogg Farm staff conduct these tours. Table 3 lists the various special interest groups that visited in 1998. Table 4 lists 1998 programs held at the Kellogg Farm. Table 5 lists the 1998 Kellogg Farm staff. In addition to full- and part-time employees the Farm hosted one intern student, Carlos Rodriguez, a Venezuelan and a recent animal science graduate from Universidad Ezequiel Zamora.

Table 1. Summary of 1998 guided and self-guided tours at the Kellogg Dairy Center.

<b>1998 Guided and Self-guided Tours</b>				
<b>Month</b>	<b>No.of Guided Tours</b>	<b>No. of Youth</b>	<b>No. of Adults</b>	<b>No.of Self-guided Tours /NO. In Group</b>
January	0	0	0	0
February	0	0	0	0
March	2	49	7	5/153
April	9	170	148	9/178
May	19	581	176	13/343
June	10	260	56	12/176

July	6	184	35	2/22
August	2	24	5	2/21
September	1	18	6	3/69
October	6	233	56	5/70
November	1	13	5	1/14
December	1	0	12	0
<b>TOTAL</b>	57	1,532	506	52/1,046

Total Number of Visitors on Guided and Self-Guided Tours:

1998: 3,084

1997: 3,548

1996: 4,497

1995: 6,205

1994: 5,286

1993: 5,794

1992: 6,069

Table 2. 1998 Kellogg Farm volunteers who guided group tours and assisted with the rotational grazing project.

<b>1998 Kellogg Farm Volunteers</b>		
Heather England Jim Engelhard Bill Ford Marjorie Kellogg	Bill Kilby Nora Kilby Judy McClelland Gene Roelofs Fred Russell	Dave Sauder Chuck Shane Jack Shoemaker Jeff Smith Margaret Wilson

Table 3. Professional and VIP tour groups that visited the Kellogg Farm in 1998, the date they visited and, in parenthesis, the approximate number of people in the group.

<b>1998 VIP Tours</b>	
03-20-98	IALE '98 Field Trip (20)
03-20-98	4-H Dairy Program (65)
03-25-98	University of Illinois (18)
06-16-98	MSU Vetword Bound Students (8)
06-19-98	ANR Institute for Minority Students (AIMS) (50)
06-24-98	YES Summer Camp (15)
06-26-98	MAP Students (14)
06-30-98	Barry County Intermediate School District (10)
08-13-98	Australian Farmers (24)

09-25-98	Chinese International Agriculture (14)
10-07-98	MSU Dairy Management Class (20)
10-23-98	Biggs-Gilmore Advertising (80)
11-07-98	MSUE & Government Officials of Eaton and Ingham Counties (18)
11-10-98	Kalamazoo Area Math and Science Center (19)

Table 4. Various programs and educational meetings held at the Kellogg Farm in 1998.

<b>Educational Meetings Held in the Dairy Center Classroom in 1998</b>	
02-13-98	Agroecology Discussion Group
03-10-98	Countrymark In-service Training
03-30-98	NRCS Conservation Planning
04-20-98	NRCS Conservation Planning
05-05-98	4-H Barnyard Buddies
05-11-98	NRCS Conservation Planning
07-17-98	AIMS Program Discussion Group
09-11-98	BioControl Training Seminar
09-18-98	MSUE AoE Livestock Agents and County Representatives- Ag. Economics
10-05-98	NRCS In-service Training
10-13-98	NRCS Conservation Planning
10-28-98	Bovine TB Workshop

Table 5. Name, job title or status, and number of years of employment with MSU for all people who worked directly for the Kellogg Farm in 1998.

<b>1998 Kellogg Farm Employees</b>		
<b>Name</b>	<b>Job Title or Status</b>	<b>Years with MSU</b>
Rob Ashley	Dairy Manager	14
James Bronson	Farm Manager	17
Patricia Foldesi	Secretary III	13
Diane Heyboer	Herder I	7
Myron (Mick) Kokx	Spec. Equip. Operator II	9
Larry Langshaw	Crop Group Leader	13
Bill Loveland	Herder I	2
Scott Neudeck	Asst. Dairy Manager	13
Greg Parker	Research Technician I	6
Shannon Perry	Herder I	6

Matt Pixley	Spec. Equip. Operator II	14
Sue Puffenbarger	Research Assistant	2
Dan Carlson	Part time-Dairy	<1
Jim Mead	Part time-Dairy	<1
Greg Miller*	Part time-Dairy	1
Don Paff*	Part time-Dairy	<1
Fred Rapp*	Part time-Dairy	2
Carlos Rodriguez*	Intern Student	April-Dec.
Karen Stollings*	Part time-Dairy	<1

\*No longer employed at the Kellogg Farm