To the Graduate Council:

I am submitting herewith a thesis written by Teffany Lynn Rich entitled "Controlling Erosion and Nutrient Loss with No-Till Transplanting." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agricultural Engineering Technology.

James B. Wills

James B. Wills, Major Professor

We have read this thesis and recommend its acceptance:

H. Paul Denton

Accepted for the Council:

Associate Vice Chancellor and Dean of The Graduate School

Controlling Erosion and Nutrient Loss with No-Till Transplanting

A Thesis

Presented for the

Master of Science

Degree

The University of Tennessee, Knoxville

Teffany Lynn Rich

December, 1997

~~AG-VetMed~~
Thesis
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To:
My parents
Betty York and Kenneth Rich
for their never ending love, support, and encouragement
throughout my educational career.

ACKNOWLEDGMENTS

The author expresses her sincere gratitude to her major professors Dr. Daniel Yoder and Mr. James B. Wills for their patience, guidance and friendship.

Appreciation and thanks is also extended to Dr. H. Paul Denton for his advice and guidance throughout this study.

Special gratitude is expressed to Mr. Richard Roy for his guidance and long hours in the laboratory.

Much thanks is extended to Chris Cobble, Angel Perky, and Erin Wilkerson for their many long hours of assistance both in the field and laboratory.

Thanks is expressed to my fellow graduate students Wesley Wright, Scott Glover, Page Barker, and Chris Wheeler. Their patience and hard work are deeply appreciated.

Special gratitude is extended to Mr. Paul Elliot and Mr. Craig Wagner for their assistance and advice.

Thanks is extended to Mr. Gary Honea for his advice and assistance.

Special gratitude is expressed to Mr. and Mrs. Mike and Lisa Groves for whose assistance helped make this study possible. Their graciousness is greatly appreciated.

Much thanks is extended to Mr. Lee Ellis and Mr. Bobby McKee for their patience, guidance, and many hours of hard work.

Gratefulness is expressed to the staff at the University of Tennessee Plant and Soil Sciences Experiment Station in Knox County, Tennessee for their many long hours in the field.

Thanks is expressed to Dr. Arnold Saxton for his guidance and advise with the statistical analysis of this study.

Thanks is expressed to Sharon Rice for her assistance during this study.

Special gratitude is expressed to my family and friends for their years of support, encouragement and infinite love.

Special appreciation is expressed to Edwin Cope for his endless patience and support. His love has made me a better person.

Much gratitude is expressed to Cheryl Ashburn for her much needed advice, encouragement, and friendship.

Special gratitude is extended to the Cope Family for their support and encouragement throughout these past two years.

Finally, all credit must go to the Lord above for without Whom this would not have been possible.

ABSTRACT

A field study was conducted to determine the effects of no-till transplanting of vegetables and tobacco on erosion and nutrient loss to surface runoff. Sediment and runoff collected from the plots were analyzed for nitrogen and phosphorus content. Information from this study will be used in the Vegetable Initiative Project conducted by the University of Tennessee Agricultural Experiment Station and Extension Service. Data collected from this study may also be used for future development of C-factor values.

This study was located at the Plant and Soil Sciences Experiment Station in Knox County, Tennessee, on an Etowah clay loam soil and at the Grove Farm in Cocke County, Tennessee, on a Jefferson sandy loam soil. The plot layout consisted of six plots for each crop grown. Three of the plots were no-till and three were conventional till. Tobacco and tomatoes were grown for two consecutive years at the Plant Science Farm. Tomatoes were grown the first year and tobacco was grown the second year at the Grove Farm. Measurements and samples were taken after each rainfall event throughout the growing season.

Results showed that no-till transplanting had a slight but significant effect on reducing runoff, with tobacco plots yielding significantly more runoff than tomato plots. A second year effect was noticeable, with more runoff measured in the second year. There was a significant difference in sediment loss between no-till and conventional till transplanting, with no-till reducing sediment loss by roughly ninety percent. Tobacco plots had significantly more sediment loss than did the tomato plots. No-till transplanting

was effective in reducing nutrient loss for both total nitrogen and total phosphorus, and nitrite and nitrate losses were less for no-till than for conventional till. Orthophosphate losses, however, were greater for no-till than for conventional till. Tobacco plots had greater nutrient losses than did the tomato plots. Surface cover for no-till plots was much greater than that of conventional till plots.

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CHAPTER 1

INTRODUCTION

Soil loss by water erosion is a major concern for crop producers (Klindt et al., 1982). Soil erosion decreases the productivity of valuable crop land by washing away topsoil, which normally has better physical, chemical, and biological properties than the underlying subsoil. Soil erosion is also a form of non-point source pollution, and some water quality problems have been associated with agricultural runoff (Barisas et al., 1978). Many studies have shown that soil erosion can be reduced by incorporating conservation tillage practices (Laflen et al., 1978.; Johnson et al., 1979; Chichester and Richardson, 1992; and Yoo et al., 1988).

Soils of the Southeastern United States are very prone to water erosion due to three main factors (Healy and Sojka, 1985). First, most soil types found in this area are characterized by having a low organic matter content, along with coarse to medium textured topsoil. These conditions tend to cause the soil to have weak particle aggregation. Given these conditions, along with years of cultivation, the soil becomes easily dislodged. The second factor affecting the rate of erosion on these soils is that this region receives on average 45 inches of rainfall annually. A large portion of this rainfall is received in the spring and summer in the form of intense storms. This rainfall comes at a time when the fields are often newly cultivated and are vulnerable to raindrop impact. The third factor affecting the erosion rates in this area is the slope of the land. Much of the crop land area in the Southeast is located on sloping land. These slopes have a dramatic impact on the rate of erosion in this area. Given these conditions, conservation tillage may provide significant benefit to long term soil productivity due to decreased erosion.

Traditional vegetable and tobacco production causes erosion due to intensive tillage and low crop residue. The no-till cropping system has been proven by a number of researchers to reduce erosion in grain crops (Shelton and Bradley, 1987), but there is little information on no-till vegetable cropping systems. This may be due to the small percentage of total acres in vegetable crops. In 1982, of the 13 million acres of no-till crops grown, only 3700 acres were in vegetables (Bartok, Jr. and Ashley, 1986). No-till production has been limited by lack of equipment and effective herbicides.

A no-till transplanter has been developed by Mr. Jim Wills of the University of Tennessee Agricultural Engineering Department (Wills, 1997). This transplanter is capable of planting in both no-till and conventional tillage systems. With the use of this transplanter and good management practices, soil erosion should be reduced dramatically.

Vegetable production can benefit from a no-till system. Cover is added to the surface, which reduces raindrop impact and runoff velocity, and which also adds organic matter to the soil. This organic matter improves soil structure and helps increase soil moisture, while protecting beneficial nutrients that could have been removed from the soil by erosion and runoff. No-till systems also benefit the grower by reducing labor costs (Chichester and Richardson, 1992). Labor costs are reduced because less time is required in preparing soil for planting. There is no need for plowing or discing or rototilling soil. Since equipment is not operated for these purposes, fuel costs are reduced. Also, tillage for weed control is eliminated.

The reduction in erosion which can be derived from changes in tillage can be estimated using models such as the Revised Universal Soil Loss Equation (RUSLE). The C-factor part of this equation is a dimensionless factor for cover and management (Renard et. al., 1994). This factor takes into account prior land use, crop canopy, surface cover, and surface roughness (National Soil Erosion-Soil Productivity Research Planning Committee, 1981). Very few values have been collected through studies on C-factors for no-till vegetable production. Information collected from this study can be used to estimate C-factors and for comparison to previous studies.

The primary goal of this study was to acquire soil loss and runoff data on no-till production using a modified no-till mechanical transplanter. The first specific study objective was to monitor and compare soil losses and runoff on conventional till and no-till plots. Since soil type affects erosion rates, two different soil types were used in this study, these being an Etowah clay loam and Jefferson sandy loam. Tobacco and tomato plants will be used in this study, since they are crops that are currently grown under both conventional and no-till conditions in this area. These crops have not been commonly no-tilled. In Tennessee, less than one percent of the total acerage of these crops have been grown under no-till conditions. Since these crops were highly erosive, no-till systems needed to be developed. Along with soil loss and runoff data, nitrogen and phosphorous losses from these plots were also monitored in the second growing season. All these data will be used by the University of Tennessee Experiment Station and Extension Service in the Vegetable Initiative Project to evaluate no-till vegetable production in Tennessee. The second project objective is to obtain cover-management information on vegetables grown on the test plots, for later use in the Revised Universal Soil Loss Equation (RUSLE).

CHAPTER 2

REVIEW OF LITERATURE

Soil erosion is a concern to both crop producers and the general public. It reduces the productivity of soils and is a large contributor to non-point source pollution. In 1992, Tennessee had an average annual soil loss of 7.1 tons per acre from cropland (USDA,NRCS, 1992). This exceeds the soil loss tolerance levels, set by the Soil Conservation Service. Wischmeier (1978) defines soil loss tolerance as the maximum rate of annual soil erosion that may occur and still permit a high level of crop productivity to be obtained economically and indefinitely. Soil formation occurs at a rate of 1 inch of topsoil for every 200-1200 years, depending on climate (Owen, 1975). Under cropping conditions, it is possible to form a maximum of about 1 inch of topsoil in 100 years. With a soil loss tolerance of 5 t/a/yr, 1 inch of topsoil would be lost in 33 years. So Tennessee soils are eroding at a rate faster that they can be reformed. Soil erosion must therefore be reduced in order to sustain long-term productivity.

Soil erosion can be reduced by means of conservation tillage practices. Conservation tillage is any tillage practice which leaves at least 30% residue cover on the soil surface after planting and reduces soil and water losses compared to conventional tillage (Yoo et al., 1989). The amount of surface cover on the soil is the determining factor in reducing soil erosion. Many studies have shown that as the residue level increases, soil loss decreases (Johnson et al., 1979; Laflen and Colvin, 1981; Laflen et al., 1978; Mostaghimi et al., 1988). Surface cover reduces soil erosion in three ways. First, it reduces raindrop impact on the soil. Second, it reduces runoff volume and velocity. Thirdly, it increases the soils' resistance to erosion.

The previously-mentioned studies have mainly focused on conventional row crops such as corn, cotton, and soybeans. Little information has been published on vegetable crops such as tomatoes, cabbage, and tobacco. These crops differ from the conventional row crops in that they are transplanted into the ground instead of seeded. In order to transplant vegetable crops, they must be planted with a mechanical transplanter. In the past, there have been no transplanters available that would plant into a no-till system. Recently a transplanter has been developed that has the capability of planting into both conventional and no-till systems. Research therefore needs to be conducted to see how well this equipment helps in reducing erosion.

Nutrient loss due to erosion has been a concern both economically and environmentally. Studies for conventional row crops grown under both conventional and conservation tillage systems have shown that nutrient loss is lower in a conservation tillage system (Yoo et al., 1989; Mostaghimi et al., 1988; Johnson et al., 1979). The same results are expected to be seen with transplanted crops.

1. Conservation Tillage

If proper conservation practices are observed, soil productivity can be maintained by keeping erosion to a minimum. Extensive research has proven that maintaining a crop residue or vegetation on the soil surface is the best means by which to reduce soil erosion. Studies have also shown that conservation tillage in many cases reduces soil and water losses, saves labor and energy, improves soil moisture content, increases yields, and helps producers realize higher net returns (Bartok, Jr. and Ashley, 1986).

Erosion affects the productivity of soil in many ways (National Soil Erosion-Soil Productivity Research Planning Committee, 1981). When topsoil is eroded, plant-available soil water capacity is decreased. Erosion decreased the depth of the root zone by removing topsoil. This topsoil usually has higher plant-available water capacity than the underlying subsoil. This puts water stress on plants, which in turn lowers crop quality and yield. Plant nutrients are also decreased by the erosion process, as many of the nutrients are found in the topsoil. Some of these nutrients attach themselves to soil particles. When the particles are washed away, so are the nutrients. Fertilizers can be added to the soil to replace these nutrients, but this increases production costs for growers. Erosion also damages the soil structure by weakening particle aggregation. This damage can occur through increased soil erodibility, surface sealing, and crusting. These problems can reduce the soil's infiltration capabilities as well as retarding seed emergence. Surface sealing reduces infiltration, which in turn increases runoff volume. In summary, soil productivity can be reduced by erosion processes.

No-till cropping has been around for many years and has been very effective in reducing erosion, yet no-till vegetable cropping is a fairly new development. There have been several problems with no-till vegetable production in the past. It has been found that most vegetables have not done as well under no-till as have other crops. Vegetable management may require more time due to weed infestation, pests, and fertilizer application, and planting equipment must be carefully operated (Bartok, Jr. and Ashley, 1986). Soils in no-till may also be susceptible to compaction. This is caused by the weight of the machinery and the machinery tires, and operating equipment on wet soils increases chances of soil compaction. Compaction reduces infiltration and limits root growth. In addition, weed infestation may become more of a problem with no-till vegetable production. One reason is that soil temperatures in a no-till system can run several degrees cooler than in a conventional tillage system. This may affect the early growth of the crop, giving the weeds a chance to catch up to the crops and to compete for water, nutrients, and sunlight.

Many studies have been conducted comparing soil losses on conventional and no-till systems. These studies have focused mainly on conventional row crops such as corn, soybeans, and cotton. Results have shown that no-till is effective in reducing soil erosion (Mostaghimi et al., 1988; Laflen et al., 1978, Johnson et al., 1979, Chichester and Richardson, 1992; Soileau et al., 1994; Yoo et al., 1987).

An illustrative example is a three year study conducted at the North Mississippi Experiment Station, Holly Springs, Mississippi comparing soil loss and runoff volumes for conventional till soybeans and no-till soybeans planted into a wheat cover crop. On average, the conventional till plots had soil losses of 7.8 tons per acre, while the no-till plots had soil losses of 0.8 tons per acre. Runoff from the conventional plots, on average, was greater than that of the no-till plots. Most of the soil from all of the plots was lost during intensive rainfall events (McGregor et al., 1975). Similar results are expected to be seen with no-till vegetable transplants.

Tobacco and tomatoes, which will be observed in this study, are two crops in this area that have potential to be grown under no-till conditions. Researchers at North Carolina State University have found that erosion can be greatly reduced using the no-tillage system with tobacco (Wood and Worsham, 1986). They reported in 1982 losing 1.1 tons of soil per acre from conventional till plots compared to 0.05 tons per acre from no-till plots. They reported in 1983 losing 8.03 tons per acre on conventional plots and 0.05 tons per acre on no-till plots. The 1983 crop was planted on a steeper slope (3.1%) than was the 1982 crop (1.3%). All no-till plots in this study were planted into a rye winter cover crop. This study also reported an average 13% lower crop yield on the no-till tobacco compared to the conventional till tobacco (Lullen, 1984).

A similar study conducted in Reidsville, NC compared runoff and erosion values from conventional and reduced tillage tobacco plots (Bathke et al., 1986). A rye cover crop was planted into the reduced tillage plots in the fall. Results showed that reduced tillage plots had significantly less soil loss than did the conventional plots. They reported in 1984 losing 7.48 tons of soil per acre on conventional plots and 0.78 tons per acre on the reduced tillage plots. They reported in 1985 losing 4.18 tons of soil per acre on the conventional plots and 0.67 tons per acre on the reduced tillage plots. Most of the soil loss resulted from intensive rainfall events. Runoff volumes for this study varied. In 1984, the conventional plots had more runoff than the reduced tillage plots, but in 1985 the conventional plots had less runoff than the reduced tillage plots. Overall the runoff volume differences between the conventional tillage and reduced tillage plots were not significant.

There are many advantages to no-till production of tobacco. One such benefit is increased surface cover, which includes crop residue, rocks, cryptogams,and other nonerodible material that is in direct contact with the soil. Surface cover prevents raindrop splash, which in a conventional system can splatter soil and trash on the leaves of the plant. This can lower the quality and sale price of the final product (Wood and Worsham, 1986). Other benefits of no-till tobacco include fuel and labor savings, increased soil moisture, reduced soil erosion, and elimination of tillage for planting and weed control (Wood and Worsham, 1986).

It is not clear which of the two tillage systems has better yields since contradictory information exists in the literature (Morse et al., 1982; Price and Baughan, 1987). It is clear, however, that increased soil losses have been found with conventional tillage systems as compared to no-tillage systems (Stirzaker et al., 1989).

2. Mechanical No-Till Transplanter

There is a limited selection of equipment available for no-till cropping systems. Unfortunately, most no-till equipment has been developed for common row crops such as corn, soybeans, and cotton. This is large-scale equipment, and usually is not adaptable to small farms. There are also not many machines which are adaptable to the wide variety of vegetables grown (Bartok, Jr. and Ashley, 1986).

A mechanical transplanter has been modified to plant in both no-till and conventional till systems by Mr. James B. Wills of The University of Tennessee. Detailed descriptions are given in Appendix A. A 14-inch fluted coulter has been added in front of the double disk opener. This fluted coulter creates a slit in the soil, which aids the double disk opener in opening a slot for the transplant. The two existing press wheels have been modified to better close the slot back around the plant. The last modification was to add an extra 250 to 300 pounds of extra weight to the rear of the transplanter, which aids the press wheels in closing the planting slot (Plate 1).

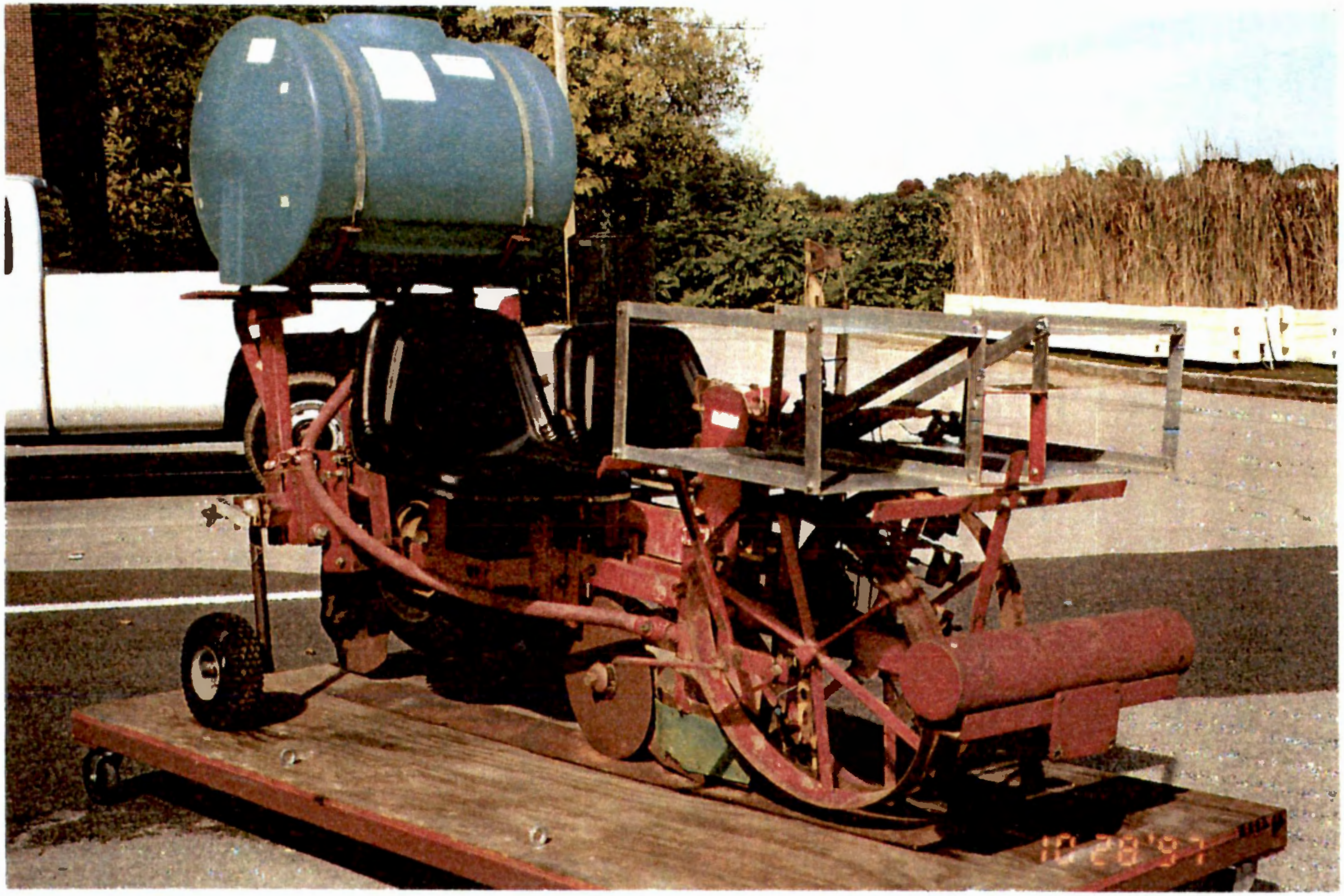

Plate 1. Photograph of no-till transplanter.

Using this technology may introduce some limitations (James B. Wills, personal communication, 1996). One such limitation is that no-till soils are harder to penetrate than soils that have been newly cultivated. Soils with low moisture content are harder to plant into than soils that are moist, so planting late in the growing season may prove to be difficult due to dry soil conditions. Transplants planted in dry conditions may not be planted deep enough. This will expose the root system, which will decrease the survivability of the plants. In the past, no-till crops planted with this transplanter have had mixed crop yield results.

On the other hand, there are benefits in using the no-till transplanter. Transplanting can be done on wetter soils than with conventional methods. Transplanting in soils with optimum moisture for planting is relatively easy with the no-till transplanter. The transplanter can be used in both conventional and no-till systems without making any adjustments to the machinery.

3. Surface Cover

Just as there is a shortage of information on no-till vegetables, there is also little information on C-factor values for these crops. This C-factor is found in both the Universal Soil Loss Equation (USLE) and in the Revised Universal Soil Loss Equation (RUSLE). It reflects the effect of cropping and management practices on erosion rates. This factor has the greatest effect on management practices in conservation plans (Yoder et al., 1997). The C-factor is a cover management term that has four main subfactors, which are prior land use, crop canopy, surface cover, and surface roughness.

A study conducted in Milan, Tennessee has found that early USLE C-factors used for estimating soil losses in no-till systems were too high (Shelton and Bradley, 1987). Later studies with soybeans and corn have found no-till RUSLE C-factors to be acceptable. However, little information has been collected on RUSLE C-factor values for vegetables and tobacco, so more research on C-factor values needs to be conducted.

Surface cover plays an important role in reducing soil erosion. The amount of surface cover has the greatest effect on soil erosion rates (Renard et al., 1991). It reduces runoff velocity and raindrop impact and improves infiltration. Surface cover includes crop residue, rocks, cryptogams, and other nonerodible material that is in direct contact with the soil surface. In collecting data on surface cover for the C-factor, the line-transect method has been proven to be effective in estimating the percentage of the ground surface covered by plant residue at any time (Laflen et al., 1981).

A study conducted near Ames and Castana, Iowa, evaluated relative soil losses and runoff amounts as affected by crop residue. The slopes at the Ames and Castana plots were 5% and 11%, respectively. Three runs were conducted at each location. Soil loss on both conventional and no-till plots at both locations were inversely correlated to the amount of residue cover on the plots. Runoff amounts at Ames were higher on the conventional plots in two out of three runs. Runoff amounts at Castana were higher on the no-till plots in all runs (Laflen and Colvin, 1981). Results indicate that surface cover helps reduce soil erosion, but does not necessarily decrease runoff volume.

A study conducted at the Plateau Experiment Station near Crossville, Tennessee, examined erosion control benefits of using manure as cover for tilled soils. Soil loss and runoff volumes were evaluated. Three different surface coverage percentages were applied to freshly tilled plots. Soil loss and runoff volume were inversely correlated to the amount of residue cover applied (Easterly, 1996), indicating that surface cover does reduce both soil erosion and runoff volume.

4. Nutrient Loss

Nutrient loss is both an economical and an environmental concern. Erosion can decrease levels of soil nutrients that are beneficial to plants. Most of the essential nutrients needed by plants are found in the top layer of soil, so many of these nutrients attach themselves to soil particles and can be eroded away. As nutrients are lost through erosion and plant uptake, fertilizer must be added to compensate for these losses. This compensation increases the production cost for the farmer.

Not only is this a problem for the farmer, but it is also a water quality problem. Runoff flowing into streams, lakes, and rivers may contain high levels of nutrients, which can cause problems for aquatic and human life. High levels of phosphorous and nitrogen can stimulate the growth of undesirable algae, in a process known as eutrophication. A standard of 0.01 mg P L^{-1} is the minimum required level that will stimulate algal growth (Vollenweider, 1968). Another nutrient-related problem is that high levels of nitrate in drinking water, can cause an illness known as methemoglobinemia in infants. The United States Public Health Service has adopted a standard of 10 mg NO_3-N L^{-1} as a safe level for drinking water (Romkens et. al., 1973).

These are a few of the problems associated with nutrient loss from agricultural watersheds. Earlier studies have shown that conservation tillage methods can reduce nutrient loss by reducing erosion and runoff (Yoo, et al., 1989; Burwell, et al., 1977; Johnson, et al., 1979; Chichester and Richardson, 1992). The nutrients of concern in this study are nitrogen (N) and phosphorus (P) , since they are the nutrients applied in the largest amounts in vegetable production.

Several studies have found that concentrations of N and P in the transported sediment are higher for conservation tillage methods than for conventional tillage methods (Yoo, et al., 1988; Johnson, et al., 1979; Barisas, et al., 1978; Burwell, et al., 1977). Since there is less soil loss with conservation tillage, however, there is less total N and P loss with conservation tillage than with conventional tillage. Concentrations of nutrients in the eroded sediment may be higher with conservation tillage than with conventional tillage because of selective soil erosion. Smaller particles are easier to dislodge than larger particles. Surface residue creates barriers which trap the larger soil particles. Therefore, in conservation tillage, clay particles make up the largest part of sediment loss. Clay particles and related amorphous constituents have a high affinity for phosphorus ions and organic molecules. There will therefore be a positive relationship between clay content and N and P concentration in the runoff sediment (Romkens et al., 1973).

A five-year study was conducted near Treynor, Iowa to evaluate the movement of N and P as influenced by applied fertilizer and tillage practice (Burwell et al., 1977). Corn was grown under both conventional and mulch tillage. The conventional tillage plots had an average annual soil loss of 8.45 tons per acre, whereas the mulch tillage plots had an average annual soil loss of 0.41 tons per acre. On an annual average, the conventional tillage plots had more surface runoff than did the mulch tillage plots. Total annual average N loss was found to be 44.81 lbs. per acre for conventional tillage and 12.60 lbs. per acre for mulch tillage. Total annual average P loss was found to be 0.85 lbs. per acre for conventional tillage and 0.24 lbs. per acre for mulch tillage. Such results indicate that conservation tillage is effective in reducing N and P loss.

A similar study was conducted in 1985 in the Tennessee Valley region of northern Alabama to determine the effect of conservation tillage systems for cotton on surface runoff and its quality (Yoo et al., 1989). This study found that the conservation tillage system had higher sediment yields than did the reduced tillage system with a cover crop. It also found that total P and N losses were higher with conventional tillage systems than with reduced tillage systems with a cover crop.

A study was conducted near Riesel, Texas to determine the sediment and N and P losses from clay soils affected by tillage (Chichester and Richardson, 1992). Wheat, corn and sorghum were grown rotationally on these plots from 1984-1989. This study found that the conventional tillage plots had an average soil loss of 0.70 tons per acre compared to 0.07 tons per acre for the no-tillage plots. Total N losses were found to be 7.22 lbs. per acre for the conventional tillage plots and 3.39 lbs. per acre for the no-tillage plots. Total P losses were found to be 1.34 lbs. per acre for the conventional tillage plots and 0.71 lbs. per acre for the no-tillage plots. All these studies report the same conclusion; conservation tillage systems reduce N and P losses compared to conventional tillage systems.

In reviewing the literature, it has been proven by many studies that no-tillage cropping systems reduce soil erosion as well as reducing nitrogen and phosphorus losses. Surface cover is the key factor in erosion control. Surface cover has been found to be inversely correlated to soil loss. Therefore, the more soil cover on the surface, the less soil erosion that will occur. A no-till transplanter has been developed which will allow producers to plant vegetables and tobacco into a no-till system, thereby providing more surface cover which will in turn reduce erosion. This transplanter is capable of operating in both a no-tillage and conventional tillage system. This will allow producers to slowly convert over to a no-till system. Soils that were once highly erodible, can be converted to no-till and soil loss will be reduced.

Knowing that no-till cropping of direct seeded crops can reduce erosion, no-till transplanting is predicted to give similar results. Only a small amount of research has been done using a no-till transplanter therefore there is limited information available on soil and nutrient loss. The purpose of this study is to determine how much soil erosion can be reduced by using a no-till transplanter, and how this will affect nutrient movement.

CHAPTER 3

PROCEDURES

A comparison of runoff, soil and nutrient losses and surface cover was made between conventional and no-tillage systems. Tobacco and tomatoes were the crops of choice for this study, since they were presently being grown under both conventional and no-till conditions in this area. Crops were planted on two different soil types to allow for soil and nutrient loss and surface cover comparisons between the two soils. Slopes of 9-10% were chosen for this study because they are typical of a majority of the farmland in East Tennessee. Three repetitions were made of each system in order to enhance statistical significance. Each system was managed under normal cropping practice recommendations made by the University of Tennessee Extension Service. Runoff volume, soil and nutrient loss, and surface cover were measured.

1. Layout and Design

In order to get representative results from this study, more than one plot of each tillage system was needed. Therefore three repetitions of each tillage system were required. A total of eighteen research plots were constructed. Twelve of the research plots were located at the Plant and Soil Sciences Experiment Station in Knox County, Tennessee, on an Etowah clay loam soil. This soil series is assigned a soil erodibility factor of K=0.303 by the Natural Resources Conservation Service. The other six plots were located at the Mike and Lisa Grove farm in Cocke County, Tennessee, on a Jefferson sandy loam soil. This soil series is assigned a soil erodibility factor of K=0.227. These plots were constructed on slopes of 9% to 10%, and measured 20 feet wide by 75 feet long. These dimensions were chosen because they are similar to those of a standard USLE research plot. A berm 2 in. to 3 in. high was built around the top and two sides of the plot, and allowed only the rainfall that fell within the plot to be collected (Plate 2).

Six of the twelve plots on the clay loam were planted in tomatoes and six in tobacco. These plots remained the same for both the 1996 and 1997 growing seasons. The six plots on the sandy loam soil were planted in tomatoes for the 1996 growing season and in tobacco for the 1997 growing season. There were three conventional plots and three no-till plots of each crop (Figure 1). All the crops were planted using the modified no-till transplanter provided by the University of Tennessee (Plate 3). Precipitation at each site was measured by a rain gauge located at the top of the slope. Measurements were recorded after each significant rain event. From the data collected, soil loss, runoff volume, and nutrient losses were calculated.

2. Berm

In order to collect only the rainfall that fell within the plot, a berm was built around the top and two sides of the plot. Refer back to figure 1 for illustration. The berm was constructed by using a roto-tiller to loosen the soil outside the desired edge of the plot.

Plate 2. Photograph of plot showing constructed berms and collection area.

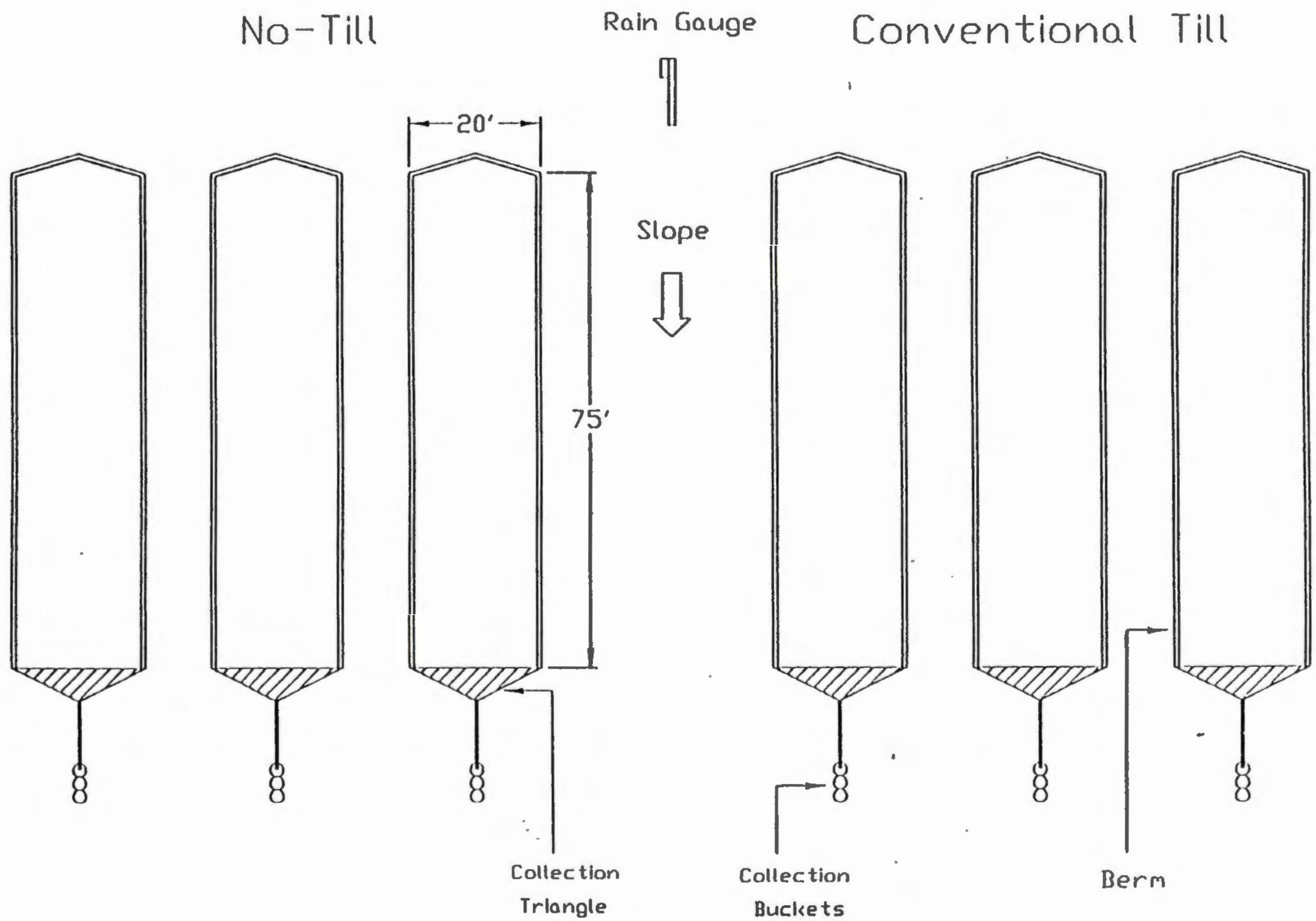

Figure 1. Plot layout.

Plate 3. Photograph of no-till transplanter in use.

After the soil was loosened, it was pulled up with a hoe to make a ridge, and was compacted to reduce erosion. Fescue seed was then spread on the berms, and they were covered with straw. This reduced erosion and prevented channelized flow where the root-tiller had been operated.

3. Collection Triangle

A collection triangle was built at the bottom of the plot to catch runoff from the plot (Plate 4). The collection triangle was designed to maintain at least a 2% slope in order to keep the sediment from settling out. This triangle was constructed by removing vegetation from the triangle collection area. This area was made as smooth as possible and then covered with a layer of black plastic to prevent vegetative growth. A layer of clear six millimeter plastic was then placed over the black plastic. A small slot four to five inches deep was made in the ground across the top of the collection triangle with a garden spade. Four to five inches of a one and a half foot by twenty foot strip of plastic was wedged down into this slit. This strip of plastic prevented runoff from going underneath the collection triangle. Two 2x4's made up the sides of the triangle. The plastic was wrapped around the 2x4's and stapled to it. The runoff from the collection triangle was diverted into a piping system that delivered the runoff into a series of 3 collection buckets. The piping system was constructed from 4 in. PVC pipe, and was installed to achieve a minimum of a 2% slope to prevent sediment from settling out.

4. Collection Buckets

A method was needed to collect the runoff coming from the collection triangles. A series of three collection buckets were located downslope from the collection triangle (Plate 5). A 2% slope was maintained in channels between buckets throughout the system in order to keep sediment from settling out. The collection buckets were placed in sumps made from 3 ft. sections of 24 in. plastic culvert. A 3 inch section of 12 inch plastic culvert was placed in the center of the sump, and filled with pea gravel to provide drainage. A three inch layer of concrete was poured between the sump wall and the 3 in. center ring. This layer of concrete provided a solid floor for the triangular base that the buckets sat upon. This triangular base was leveled by turning screws that were placed in each corner of the triangle. It was very important that the collection buckets be level to ensure that the flow dividers on the buckets split flow evenly. For instances when the sumps filled with water during heavy rainfall events, several one inch holes were cut out of the side of the sumps to allow for drainage. These holes were placed at a level below the bottom of the flow dividers. This prevented runoff water in the sumps from interfering with the flow dividers.

The first two of the three buckets had flow dividers connected to them. The flow dividers were connected by channels made from galvanized sheet metal. The collection buckets and sumps were covered by an A-frame teepee. Refer back to plate 5 for photograph of teepee. This teepee was covered with the same 6 mil plastic that was used in construction of the collection triangles. This teepee prevented unwanted precipitation and trash from falling into the collection buckets.

5. Flow Divider

In order to reduce the total volume of runoff collected, a flow divider was needed to split the flow. A flow divider designed by faculty of the University of Tennessee Agricultural Engineering Department was used in this study (Plate 6). This was a circular flow divider that was attached to a 5-gallon bucket lid, whose center had been cut out. This design allowed one to easily screw the flow divider on and off of the collection bucket. The divider was made up of 24 V-notched weirs. When the flow divider and bucket apparatus were level, runoff flowed evenly out of all 24 weirs. This design was tested in the laboratory and found to have a 2%-5% margin of error. Runoff from the plot flowed into the first bucket and divider and, once the bucket was filled, additional flow was split twenty-four ways. One twenty-fourth of the flow was channeled into the second bucket. Again, when this second bucket was full and overflowed, this excess flow was split twenty-four ways and one twenty-fourth of this overflow was channeled into a third bucket. The third bucket did not have a divider on it. This type of divider permitted a large volume of runoff to flow through the series of divider buckets, but only a small portion was actually collected for analysis. The portion collected was theoretically a representative composite sample of the total volume.

When estimating runoff volume, the shape of the buckets was taken into account, so the volume in the bucket was determined by measuring the depth of water in the bucket

Plate 4. Photograph of collection triangle.

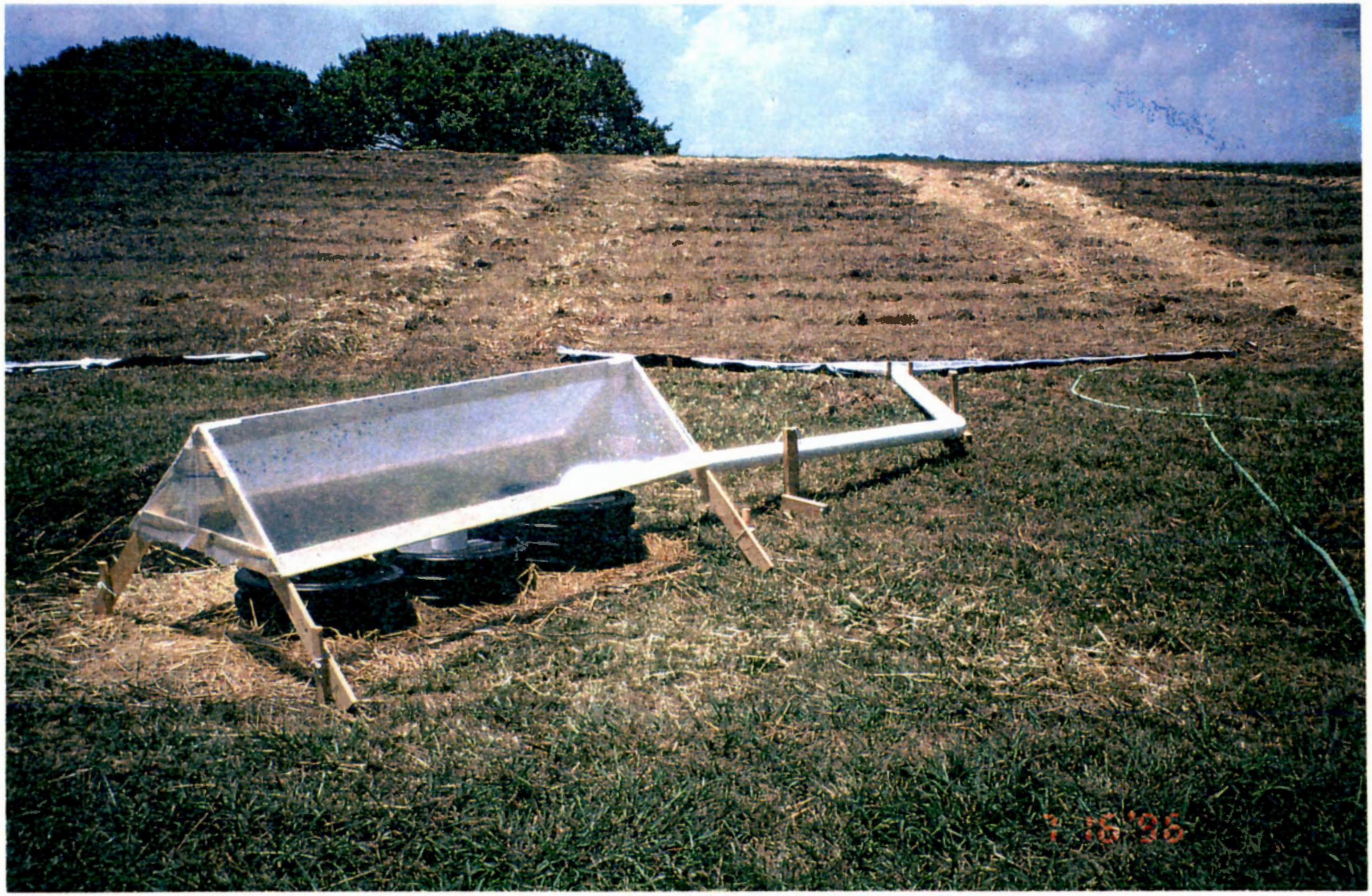

Plate 5. Photograph of collection buckets, sumps, and A-frame teepee cover.

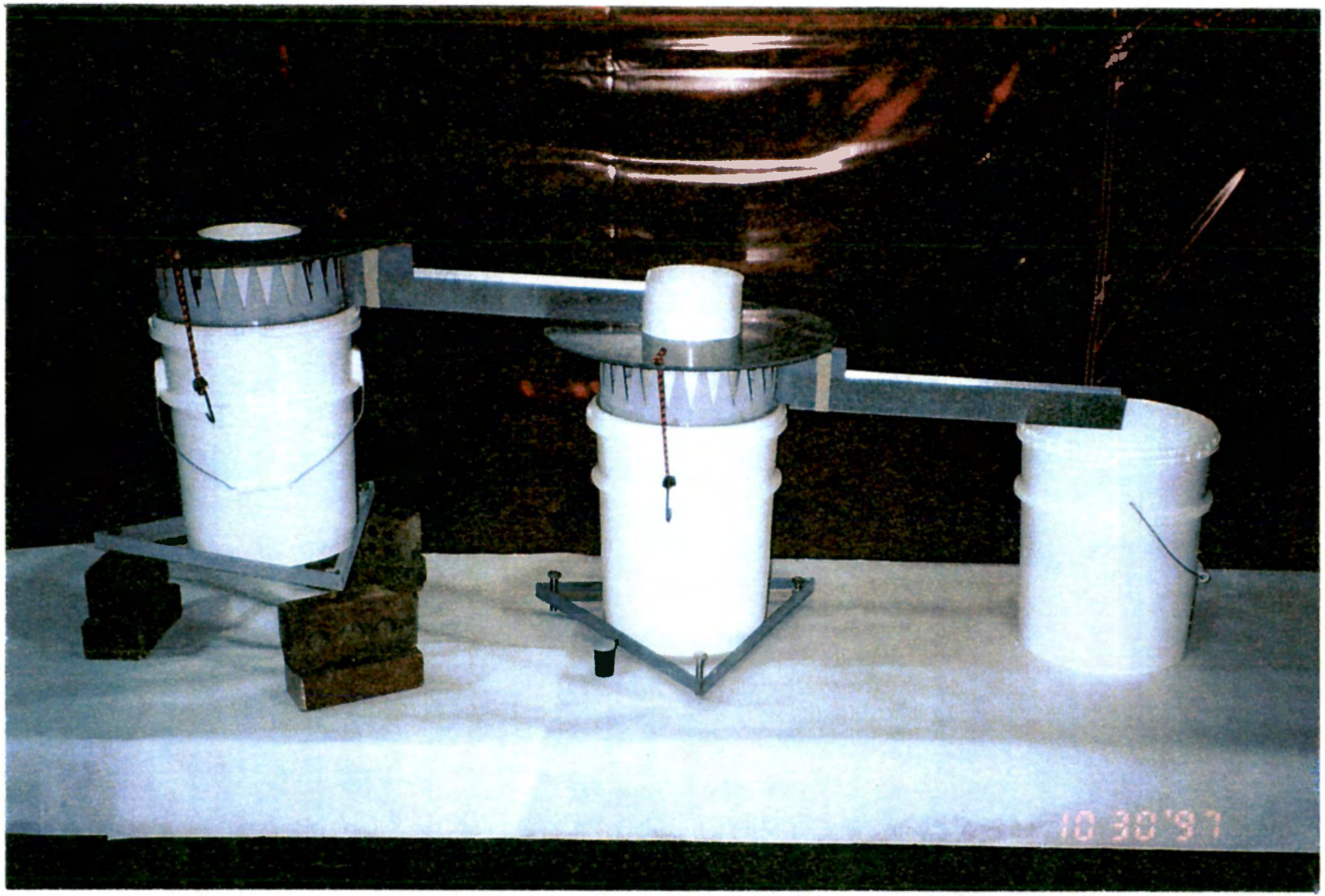

Plate 6. Photograph of collection bucket setup showing flow dividers.

and entering this value into a volume relationship. The volume in the second bucket had to be multiplied by 24 to take into account that the flow that was split by the 24 V-notched weirs in the flow divider from the first bucket. Likewise, the volume in the third bucket had to be multiplied by 24 twice to take into account the flow that was split by the flow dividers in both the first and second bucket.

6. Data Collection

Data was collected during the growing season only. Data in 1996 was collected from July 16th to November 4th at the Plant Science Farm. Also in 1996, data was collected at the Grove Farm from August 14th to November 7th. Data in 1997 was collected at the Plant Science Farm from July 3rd to October 1st. Data in 1997 at the Grove Farm was collected from July 9th until October 2nd. Collection went from time of transplanting up until a few weeks after harvest. Refer to Appendices B and C for cropping practices and collected data.

In order to calculate runoff volume, precipitation amounts and water levels in the buckets were measured. Soil and runoff that had collected in the buckets was measured and sampled in order to calculate total soil and nutrient losses from the individual plots. When collecting data, the precipitation from the rain gauges and the water level in each bucket were recorded. The first bucket was replaced with a clean bucket, and the entire runoff and sediment in the bucket was taken to the lab for analysis. It was hypothesized that a majority of the heavier soil particles would settle out in the first bucket, thereby not allowing a representative grab sample of the mixture in the first bucket. Any runoff in the second bucket was measured, mixed thoroughly, a grab sample taken, and the remaining runoff was discarded. This was repeated for the third bucket. The collection system was then made ready for the next rainfall event.

After runoff samples settled in the first bucket for at least twenty-four hours, the supernatant water was pumped off. The remaining sediment and water was transferred into baking pans. The sediment was dried at 105 degrees Celsius to remove all soil moisture, and was then weighed. It was baked at 500 degrees Celsius for one hour to remove all organic matter and then reweighed for final measurement. The smaller grab samples from the second and third bucket were treated in the same manner.

Nutrient loss was analyzed from a sample of the runoff and sediment. This analysis was done by personnel in the Water Quality Lab in the Agricultural Engineering Department. Nitrogen levels in the runoff were measured by using Lachat Instrument Method #10-107-06-2-D, which was developed from total Kjeldahl nitrogen (TKN) tests using Environmental Protection Agency Method 351.2 (USEPA, 1983). This method measured organic nitrogen and ammonia. EPA Method #300.0 was used to measure nitrite and nitrate concentrations (USEPA, 1991). The results from both of these methods were added together to give total nitrogen. The data was received in concentration form, with a minimum detection level at 0.2 mg nitrogen per liter. The concentration found in the sample was multiplied by total volume of runoff to calculate the total mass of N lost.

Total Kjeldahl nitrogen in the sediment was measured by using Lachat Instrument

Method 13-107-06-2-D. This method was developed from the Methods Manual for Forest Soil and Plant Analysis, Information Report NOR-X-39 (Kaltra and Maynard, 1991). This method will measure organic nitrogen and ammonia. This data was received in percentage form, and the percentage was multiplied by the total mass of sediment collected off of the plot to get a total mass of N lost. The minimum detectable level was 0.2 mg nitrogen per L.

Total phosphorus in the runoff was measured by using Lachat Instrument Method #10-115-01-1-C developed from the block digester method suggested by the Environmental Protection Agency, Method 365.4 (USEPA, 1983). EPA Method #300.0 was used to measure orthophosphate (USEPA, 1991). Results was received in grams of phosphorus per liter of sample, with a minimum detection level of 0.01 mg phosphorus per liter. The mass of total phosphorus was found by multiplying the concentration by the runoff volume from the plot.

Total Kjeldahl phosphorus in the sediment was measured by using Lachat Instrument Method #13-115-01-1-B. This method was developed from the Methods for Determination of Inorganic Substances in Water and Fluvial Sediments (USGS, 1989). The concentrations were reported in percentage form, with a minimum detection level of 0.01%. The percentage was multiplied by the total mass of sediment collected off of the plot to get a total mass of P lost.

7. Residue Cover Measurement

The amount of residue cover on the soil surface has a great effect on the rate of erosion. Therefore, residue cover measurements were needed in order to compare the effects of residue cover on soil loss between a conventional and no-till system. Residue cover was measured once a month from the time of planting up to harvest. Measurements were made using the line transect method. A 100 foot measuring tape was stretched across a plot at a 45 degree angle off the row direction in a representative area of the plot. Residue that was large enough to intercept raindrops was counted. This was residue that was at least 3/32 of an inch in diameter. The number of points under which residue was detected gave the percent residue cover. Three measurements for each plot were made and then averaged for a mean residue cover percentage (Laflen, et. al., 1981).

8. System Performance

The collection system as a whole performed well. A few problems were encountered but they were easily fixed. The berms around the plots remained intact throughout the growing season, though the conventional till plot berms had to be reformed on occasion. This was usually required after cultivation practices, when tractor tires would flatten berms by driving over them. No-till berms held up very well, and did not have to be reformed the second year of study. The no-till berms were smaller the second year, but what remained from the first year worked effectively. These berms would eventually have to be reformed after a few years of use.

The collection triangles performed very well. The plastic on the triangle had to be replaced the second year due to damage from sunlight and insects. Some of the plastic on the teepee cover had to be replaced the second year due to damage from sunlight, wind, and insects.

Collection buckets also performed well. There was a problem with some of the buckets floating up when collection sumps filled with water during rainfall events, but this was resolved by attaching three elastic chords to the bucket and securing them to the concrete floor. Holes drilled in the sides of the sumps allowed enough drainage that overflow runoff did not interfere with operation of the flow dividers.

9. Crop Quality

Crop quality was very poor in the first year of study at the Plant Science Farm. Both tobacco and tomato plots suffered plant loss due to drought conditions after transplanting. Soil fertility at the Plant Science Farm was not optimal the first year, which had a great effect on the plant quality. The pH was too low for optimal tobacco and tomato production. Several plants had to be replaced at the beginning of the growing season, which may have caused poor coverage, possibly affecting the results. Weeds were not controlled very well at the Plant Science Farm. These added to surface cover, which could have an affect on data results. Tomato plants at the Grove Farm in 1996 were of exceptional quality. Weeds were kept under control on these plots.

Tobacco plants at both the Plant Science Farm and Grove Farm were not of good quality in the second year of study. Rainfall amounts were low, which could have affected the plants at the Grove Farm. Tobacco plants at the Plant Science Farm were irrigated in 1997, so they did not suffer from drought stress. The tobacco plants at the Plant Science Farm did suffer from chemical damage. Though the exact source of chemical damage could not be pin-pointed, it appears to have come from the sprayer that was used to apply herbicide to the tobacco plots. Tomatoes at the Plant Science Farm did very well the second year of study. They were also irrigated and did not suffer from drought stress.

Weeds were a problem the second year at both locations. Weed population was more dense at the Grove Farm. These weeds added to surface cover, which could have affected the data results.

10. Data Analysis

The plot layout was designed with the three repetitions side-by-side. Plots were arranged in this manner due to ease of management practices. Refer back to figure 1 for plot layout. All no-till plots had to be treated the same, as did all of the conventional plots. Since there were small variations in the slope at the research sites, the no-till plots were placed on the steepest part of the slope to prevent data from being biased. By doing this, no-till plots were given the worst situation.

SAS was used to statistically analysis the data (SAS Institute, 1989). LSMeans comparison was used to estimate the means and test all pairwise differences among the means. Least Significant Difference tests (alpha=0.05) were performed on the data. Log transformations were used to normalize the data. Refer to Appendix F for SAS programs used in this analysis. Means listed in the tables are reported in untransformed form.

CHAPTER 4

RESULTS

As stated previously, this project was undertaken to acquire soil loss and runoff data on no-till production using a modified no-till mechanical transplanter. Soil loss and runoff data were acquired from no-till and conventional till plots, and were analyzed to determine the effect of no-till transplanting of vegetables and tobacco on soil erosion. In the second year of study, the effect of no-till production on nutrient movement was also analyzed in soil and runoff samples taken after each rainfall event. Also in the second year of study, surface cover measurements were made once a month from the time of planting up until time of harvest.

This chapter will report on comparisons of runoff amounts between no-till and conventional till plots. Sediment loss comparisons between the two cropping methods will also be made, as will comparisons of these nutrient losses between the two cropping systems.

1. Runoff

Runoff was calculated as a percentage of the total rainfall that fell within the plot. Total study period rainfall amounts for each location are given in Table 1. Differences in rainfall amounts can be attributed to the location of the research plots and the number of times samples were collected for each system. Overall, the general trend was towards slightly less runoff from no-till than conventional till, and less runoff from tomatoes than tobacco (Table 2). However, there were some mixed results, which make it difficult to draw definitive conclusions.

There appears to be a "second year" effect in the data from the Plant Science Farm. Massive root systems from the original fescue cover may have provided surface cover and preserved soil structure, which helped increase infiltration in the first year. In the second year, much of the root system from the fescue cover may have decayed, perhaps decreasing infiltration rates, which would result in more runoff in the second year (Yoder et al., 1997). This could be supported by the fact that there was more runoff in the second year but less rainfall. However, timing and intensity of rainstorms in the two years could also make a difference in runoff amounts.

Table 1. Rainfall data expressed in centimeters.

Rainfall (centimeters)			
Year	Plant Science Farm Tobacco	Plant Science Farm Tomatoes	Grove Farm
1996	33.81	28.83	20.32
1997	23.67	24.21	15.77

Table 2. Runoff averages expressed as a percentage of rainfall.

Runoff as a Percent of Rainfall					
Year	Cropping Method	Plant Science Farm		Grove Farm	
		Tobacco	Tomatoes	Tobacco	Tomatoes
1996	Till	8.42 cd	0.56 h		13.29 a
	No-Till	3.6 ef	0.78 h		8.74 c
1997	Till	33.33 a	2.82 g	5.24 h	
	No-Till	26.47 ab	3.42 fg	1.27 de	

* Treatments with different letters are statistically different.

2. Sediment Yield

There was a significant difference between no-till and conventional till sediment loss amounts (Table 3). The general trend was towards much less sediment loss from no-till than conventional till, and less sediment loss from tomatoes than tobacco. There were some mixed results, however, which makes it difficult to draw a definite conclusion as to whether tomatoes will always have less sediment loss.

There appears to be a "second year" effect in the data from the Plant Science Farm. In the first year of the study, the crops were planted into a killed fescue cover that had been in place for several years. This fescue had an extensive root system that did not fully decompose the first year of the study. This root system held the soil together, which helped reduce the first year sediment loss. By the second year, much of the root system had decomposed, which allowed the soil particles to be more easily dislodged which increased the sediment yield for that year. Soils also become more erodible over time due to the breakdown of particle aggregation caused by erosion. This effect was not seen at the Grove Farm. The cover crop here was not well established.

Another factor affecting the erosion rates of the two tillage methods is the amount of surface cover on the soil. The no-till plots had more surface cover than did the till plots (Table 4).

Table 3. Sediment yield averages for cropping methods expressed in lb/A.

Sediment Yield in lb/A					
Year	Cropping Method	Plant Science Farm		Grove Farm	
		Tobacco	Tomatoes	Tobacco	Tomatoes
1996	Till	184 e	7.4 gh		3074 a
	No-Till	8.9 g	0.31 h		878 d
1997	Till	9238 b	115 de	295 c	
	No-Till	102 f	11.9 g	4.1 g	

* Treatments with different letters are statistically different.

Table 4. Surface cover averages for cropping methods expressed in percent.

Percent Surface Coverage						
Location	Plant Science Farm Tobacco		Plant Science Farm Tomatoes		Grove Farm Tobacco	
Date	No-Till	Till	No-Till	Till	No-Till	Till
7-7-97	68	17	80	28	83	26
8-5-97	70	19	65	17	84	23
9-4-97	78	19	65	25	80	25
10-3-97	78	17	72	22	74	19

* Averages calculated from three surface cover measurements per plot.

3. Nitrogen Movement

Tillage method also had a significant effect on nitrogen movement. Overall, there was less total N loss from no-till than from conventional till, and less total N loss from tomatoes than tobacco (Table 5).

The greatest amounts of nitrogen were lost near the beginning of each growing season. This would be close to the date of the initial fertilizer application (Appendix B). Hence, applied fertilizer that had not been incorporated into the soil and taken up by plants seems to have been washed away with the first rainfall events of the season.

Tillage method also seemed to have an effect on NO_2 and NO_3 movement (Table 6). Overall, there was less NO_2 and NO_3 loss from no-till than conventional till, and less NO_2 and NO_3 loss from tomatoes than tobacco. However, there were some mixed results, which make it difficult to draw a definite conclusion as to whether tomatoes will always have less NO_2 and NO_3 loss.

The greater portion of NO_2 and NO_3 that was lost occurred at the beginning of the growing season. This was, as was noted before with total N, soon after the initial fertilizer application (Appendix B). NO_2 and NO_3 made up 4-10% of the total N that was lost.

Table 5. Total N averages for cropping methods expressed in lb/A.

Total N movement in lb/A					
Year	Cropping Method	Plant Science Farm		Grove Farm	
		Tobacco	Tomatoes	Tobacco	Tomatoes
1997	Till	110 a	1.68 c	2.78 b	
	No-Till	5.26 cd	0.62 d	0.26 cd	

* Treatments with different letters are statistically different.

Table 6. Total $NO_2 + NO_3$ averages for cropping methods expressed in lb/A.

Total $NO_2 + NO_3$ movement in lb/A					
Year	Cropping Method	Plant Science Farm		Grove Farm	
		Tobacco	Tomatoes	Tobacco	Tomatoes
1997	Till	2.74 a	0.08 b	0.26 a	
	No-Till	1.5 a	0.05 b	0.06 b	

* Treatments with different letters are statistically different.

4. Phosphorus Movement

Tillage method made a significant difference in the movement of total P. Overall, there was less total P loss with no-till than with conventional till, and less total P loss with tomatoes than with tobacco (Table 7).

Tillage method also had a significant effect on the movement of PO_4 (Table 8). Overall, the general trend was towards more PO_4 loss from no-till than conventional till. However, there were some mixed results, which make it difficult to draw a definite conclusion as to whether no-till will always have more PO_4 loss than conventional till. A larger percentage of the total P from the no-till plots was made up of PO_4 than the total P from the conventional till plots.

Table 7. Total P averages for cropping methods expressed in lb/A.

Total P movement in lb/A					
Year	Cropping Method	Plant Science Farm		Grove Farm	
		Tobacco	Tomatoes	Tobacco	Tomatoes
1997	Till	1.86 a	0.05 c	0.76 a	
	No-Till	0.54 c	0.04 c	0.08 b	

* Treatments with different letters are statistically different.

Table 8. Total PO_4 averages for cropping methods expressed in lb/A.

Total PO_4 movement in lb/A					
Year	Cropping Method	Plant Science Farm		Grove Farm	
		Tobacco	Tomatoes	Tobacco	Tomatoes
1997	Till	0.0005 c	0.0006 c	0.68 a	
	No-Till	0.44 b	0.03 b	0.05 a	

* Treatments with different letters are statistically different.

Results indicate that sediment and nutrient loss can be controlled with no-till transplanting. Conventional till plots had slightly more runoff than no-till plots. There was significantly more sediment loss from conventional till than from no-till. Nutrient loss seemed to be linked to sediment loss. Total N and P loss were reduced with no-till transplanting. Total NO_2 and NO_3 had similar results. There was more total PO_4 loss from no-till than from conventional till.

CHAPTER 5

SUMMARY AND CONCLUSIONS

The goal of the study was to determine how no-till transplanting of vegetables and tobacco affected erosion and nutrient movement.

Research showed that no-till transplanting reduced runoff by a small margin. The results were mixed, and a definite conclusion cannot be made as to whether no-till transplanting will always reduce runoff. There also appeared to be a "second year" effect, where runoff volume was greater in the second year of study. This may be due to residual effects of the sod rootmass from the original fescue cover.

Sediment yields were much lower for the no-till cropping systems than for the conventional till cropping systems, and tobacco was found to have higher erosion rates than tomatoes. Surface cover that was measured throughout the growing season showed that no-till provided much more surface cover than did conventional till, which could explain the large differences in sediment loss. No-till sediment loss ranged from 1 to 29% of that from conventional till.

No-till transplanting was also effective in reducing the amount of total N coming off of the no-till plots, with nitrogen amounts in the sediment greater than those in the runoff. Therefore, as sediment loss increased, so did total N movement. Tobacco plots seemed to have more total N loss than tomatoes. This may be primarily due to the larger sediment loss that occurred on the tobacco plots. No-till transplanting was also effective in reducing the amounts of NO_2 and NO_3 leaving the plot. The NO_2 and NO_3 movement was similar to the total N movement. The more sediment loss that occurred, the more NO_2 and NO_3 loss there was.

Results indicated that no-till transplanting also reduced the total P movement. More total P loss occurred on conventional till plots than on no-till plots, with more total P loss occurring on tobacco than on tomatoes. As mentioned before, this is primarily due to the larger sediment loss that occurred on tobacco plots. There was however, greater PO_4 loss on the no-till plots than on the conventional till plots. A higher percentage of the total P loss in no-till was made up of PO_4, than was the case in the conventional plots.

Based on the results of this study, it seems that no-till transplanting of vegetables and tobacco is effective in reducing erosion. This method of planting was also found to be effective in reducing nutrient movement.

Results from this study were promising. However, further studies should be conducted to confirm these results. A study with year-round collection would make it more possible to perform erosion control prediction using an erosion prediction model such as RUSLE.

Soil fertility problems at the Plant Science Farm did not allow for good growing conditions for tobacco and tomato plants the first year. Disease, weeds and drought conditions also hampered plant growth. Data obtained from ideal growing situations would be helpful. A complete set of data was missing in the analysis for the 1996 growing season at the Grove Farm. This was due to a malfunction in the collection sumps. Therefore, more data needs to be collected to confirm findings.

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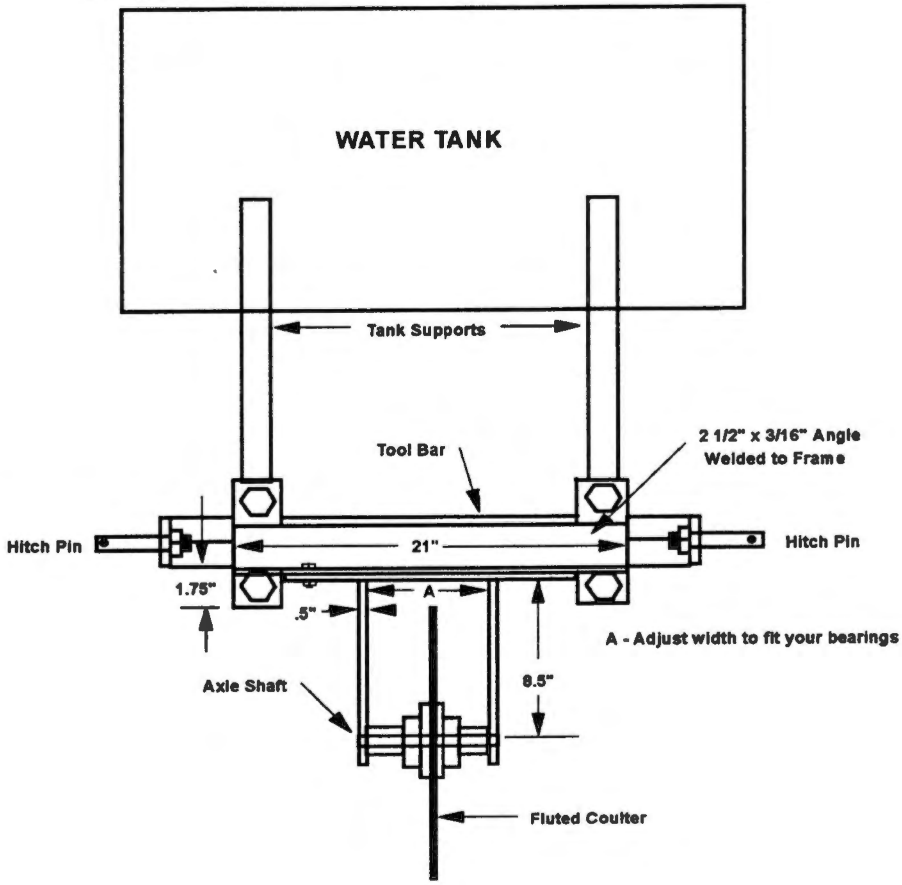
APPENDICES

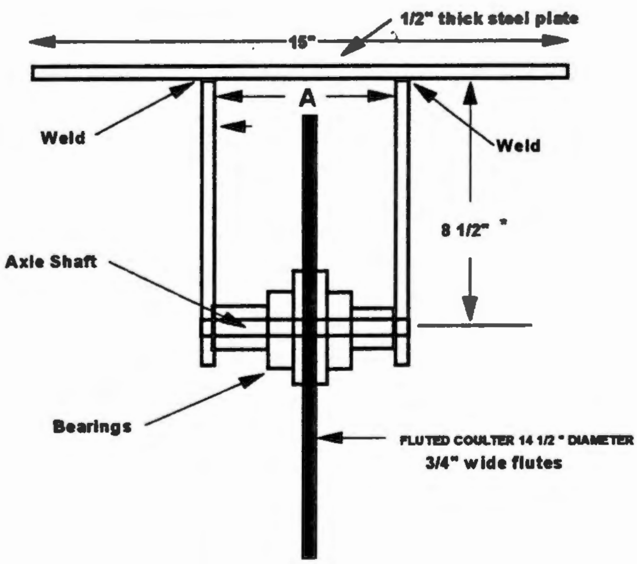
Appendix A.

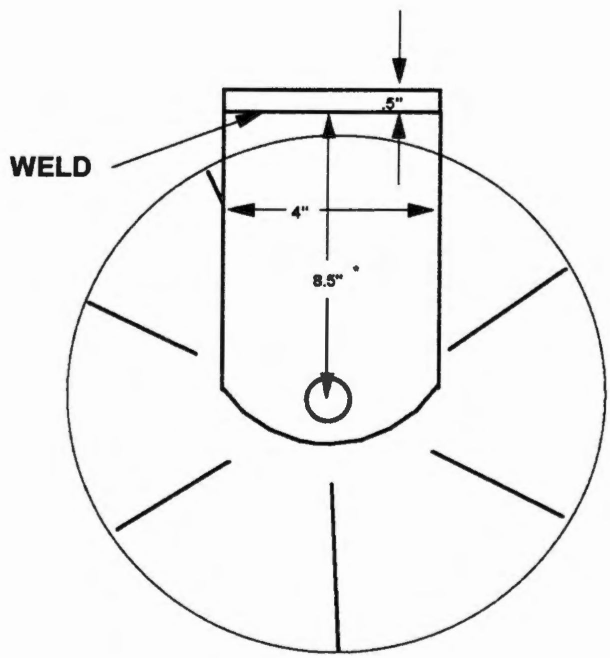
Transplanter Modifications

FRONT VIEW OF FLUTED COULTER ADD-ON TO MECHANICAL MODEL 1000 TRANSPLANTER



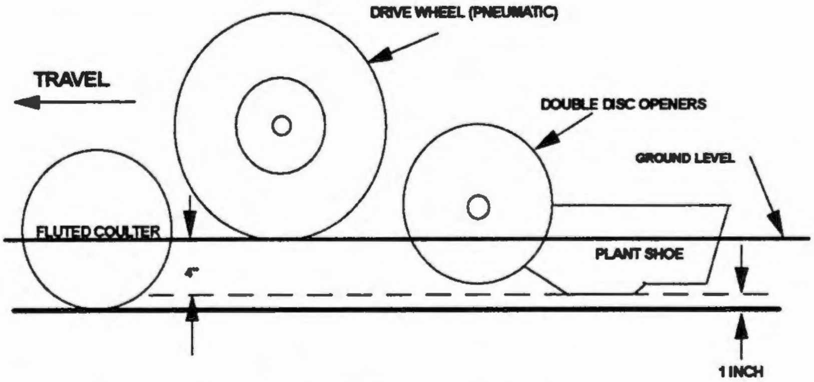
VIEW OF COULTER ASSEMBLY





SIDE VIEW OF FLUTED COULTER
AND MOUNTING ASSEMBLY
14 1/2 INCH DIAMETER COULTER

FLUTED COULTER SHOULD OPERATE
ABOUT ONE INCH DEEPER
THAN BOTTOM EDGE OF PLANT SHOE



SIDE VIEW OF FLUTED COULTER
WITH RESPECT TO DRIVE WHEEL
DISC OPENERS AND PLANT SHOE

Appendix B.

Management Practices

Management Practices
U. T. Plant & Soil Science Farm
Tobacco Plots

Date	Plot	Management Practice
6/10/96	All	4% Roundup® treatment by hand (burndown)
6/11/96	Conventional	Plowed conventional plots
6/13/96	Conventional	Roto-tilled conventional plots
6/13/96	All	200 lbs/acre of 5-10-15 fertilizer
6/13/96	All	4 lbs/acre of Devrinol® 50 DF herbicide applied
6/14/96	All	Tobacco plants transplanted with no-till setter
6/27/96	No-till	4% Roundup® treatment by hand (burndown)
9/14/96	All	Tobacco plants harvested
10/01/96	All	Rye cover crop planted
2/25/97	All	2880 lbs/acre pelletized lime broadcast applied
3/24/97	All	1.5 qts/acre Roundup® treatment (burndown)
4/24/97	All	4% Roundup® treatment
6/02/97	Conventional	Roto-tilled uphill
6/02/97	All	600 lbs/acre 10-10-10 fertilizer broadcast applied
6/03/97	All	3 pts/acre Prowl® herbicide applied
6/04/97	All	Tobacco plants transplanted
9/22/97	All	Tobacco plants harvested

* Lime and fertilizer application rates based on soil tests results
*Cropping practice recommendations made by University of Tennessee Extension Service
*Cropping practices carried out by University of Tennessee Agricultural Experiment Station Plant and Soil Science Unit staff

Management Practices
Knox County/U. T. Plant & Soil Science Farm
Tomatoe Plots

Date	Plot	Management Practice
6/10/96	All	4% Roundup® treatment by hand (burndown)
6/11/96	Conventional	Plowed conventional plots
6/13/96	Conventional	Roto-tilled conventional plots
6/13/96	All	569 lbs/acre of 12-24-24 fertilizer
6/14/96	All	Tomato plants transplanted with no-till setter
6/27/96	No-till	4% Roundup® treatment by hand (burndown)
9/15/96	All	Tomato plants harvested
10/01/96	All	Rye cover crop planted
2/25/97	All	2880 lbs/acre pelletized lime broadcast applied
3/24/97	All	1.5 qts/acre Roundup® treatment (burndown)
4/24/97	All	4% Roundup® treatment
5/01/97	Conventional	Roto-tilled uphill
5/01/97	All	600 lbs/acre 10-10-10 fertilizer broadcast applied
5/07/97	All	Tomato plants transplanted
9/05/97	All	Tomato plants harvested

* Lime and fertilizer application rates based on soil tests results
*Cropping practice recommendations made by University of Tennessee Extension Service
*Cropping practices carried out by University of Tennessee Agricultural Experiment Station Plant and Soil Science Unit staff

Management Practices
Cocke County/Grove Farm
Tomatoes and Tobacco

Date	Plot	Management Practice
6/21/96	All tomato plots	Paraquat® herbicide sprayed as a burndown treatment
6/26/96	Conventional tomato plots	Plowed conventional plots
6/26/96	Conventional tomato plots	Roto-tilled conventional plots
6/26/96	All tomato plots	12-24-24 fertilizer applied at recommended rates
6/28/96	All tomato plots	Tomato plants transplanted
7/05/96	All tomato plots	Ammonia nitrate added every two weeks after planting at recommended rates
7/05/96	Conventional tomato plots	Cultivated in between rows every two weeks after planting
9/18/96-10/25/96	All tomato plots	Harvested tomatoes
9/25/96	All tomato plots	Planted a rye cover crop
6/12/97	All tobacco plots	Paraquat® herbicide sprayed as a burndown treatment
6/19/97	Conventional tobacco plots	Roto-tilled conventional plots
6/19/97	All tobacco plots	Recommended fertilizer applied
6/20/97	All tobacco plots	Tobacco plants transplanted
7/01/97	Conventional tobacco plots	Roto-tilled conventional plots
7/01/97	All tobacco plots	200 lbs/acre ammonia nitrate side dressed
9/27/97	All tobacco plots	tobacco plants harvested

* Lime and fertilizer application rates based on soil tests results
*Cropping practice recommendations made by University of Tennessee Extension Service
*Cropping practices carried out by Mike and Lisa Grove

Appendix C.

Raw Data

Appendix C

Nomenclature

A	sediment yield
B	tobacco
B1	bucket one
B2	bucket two
B3	bucket three
bot	bottle
C	Cocke County
d	depth
K	Knox County
l	liters
M	tomatoes
NT	no-till
Ppt	precipitation
RO	runoff
SD	standard deviation
TL	conventional till
Tot	total

Plant Science Farm July 16, 1996

	PPt (in)	1.47															
Tobacco	B1		B2			B3			Tot	RO as	A						
Plot	d(cm)	soil(g)	d(cm)	bot(g)	soil(g)	d(cm)	bot(g)	soil(g)	RO(l)	%PPT	(kg/ha)						
1	32.7	5.97	12.86	533.42	0.06	0.00	0.00	0.00	188.08	4.02%	2.03			RO avg	ROSD	Aavg	ASD
2	32.39	6.95	27.15	533.42	0.09	0.00	0.00	0.00	391.46	8.36%	5.49	K0716B	NT	7.44%	3.06%	5.05	2.82
3	31.75	30.48	32.07	533.42	0.08	0.00	0.00	0.00	465.15	9.93%	7.61	1.47	TL	7.50%	1.75%	105.80	71.96
4	31.91	110.6	18.26	533.42	1.07	0.00	0.00	0.00	262.51	5.61%	48.30						
5	31.43	269.5	29.37	533.42	2.78	0.00	0.00	0.00	424.02	9.05%	186.50						
6	31.75	64.05	25.56	533.42	1.50	0.00	0.00	0.00	367.56	7.85%	82.60						

* Note that plots 1-3 are no-till and plots 4-6 are conventional till.

Plant Science Farm July 29, 1996

	PPt (In)	2.22															
Tobacco	B1		B2			B3			Tot	RO as	A						
Plot	d(cm)	soil(g)	d(cm)	bot(g)	soil(g)	d(cm)	bot(g)	soil(g)	RO(l)	%PPT	(kg/ha)						
1	32.39	1.74	21.27	533.42	0.00	0.00	0.00	0.00	305.63	0.04	0.14			RO avg	ROSD	Aavg	ASD
2	32.07	1.48	13.49	533.42	0.00	0.00	0.00	0.00	196.30	0.03	0.12	K0729B	NT	0.03	0.01	0.23	0.17
3	28.90	5.33	6.70	533.42	0.00	0.00	0.00	0.00	103.08	0.01	0.42	2.22	TL	0.07	0.01	19.17	18.26
4	32.07	80.83	24.61	533.42	0.00	0.23	0.00	0.00	423.68	0.06	6.43						
5	32.07	503.82	18.73	533.42	0.00	0.80	0.00	0.00	512.65	0.07	40.09						
6	32.39	138.15	30.96	533.42	0.00	0.53	0.00	0.00	609.77	0.09	10.99						
Tomatoes																	
Plot	PPt(In)	2.22															
1	32.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.82	0.00	0.00			RO avg	ROSD	Aavg	ASD
2	31.91	1.00	8.26	533.42	0.00	0.00	0.00	0.00	125.61	0.02	0.08	K0729M	NT	0.01	0.01	0.03	0.05
3	32.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.82	0.00	0.00	2.22	TL	0.00	0.00	0.96	1.10
4	32.22	23.00	2.38	533.42	0.07	0.00	0.00	0.00	49.02	0.01	2.17						
5	32.39	9.00	0.00	0.00	0.00	0.00	0.00	0.00	18.82	0.00	0.72						
6	28.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.61	0.00	0.00						

* Note that plots 1-3 are no-till and plots 4-6 are conventional till.

Plant Science Farm August 1, 1996

	PPt (in)	2.79															
Tobacco	B1		B2			B3			Tot	RO as	A						
Plot	d(cm)	soil(g)	d(cm)	bot(g)	soil(g)	d(cm)	bot(g)	soil(g)	RO(l)	%PPT	(kg/ha)						
1	31.75	3.26	31.43	535.43	0.07	0.00	0.00	0.00	455.39	5.12%	4.69			RO avg	ROSD	Aavg	ASD
2	32.07	6.50	23.50	540.27	0.04	0.00	0.00	0.00	337.64	3.80%	2.39	K0801B	NT	4.65%	0.74%	3.25	1.25
3	31.75	33.57	30.80	533.42	0.00	0.00	0.00	0.00	445.82	5.02%	2.67	2.79	TL	22.47%	30.15%	72.60	56.84
4	31.75	67.50	31.59	549.87	0.67	14.61	512.75	0.06	5092.03	57.28%	91.12						
5	31.75	234.89	31.75	548.84	1.59	0.00	0.00	0.00	460.26	5.18%	117.67						
6	31.91	110.83	30.48	533.42	0.00	0.00	0.00	0.00	441.08	4.96%	8.82						
Tomatoes																	
Plot	PPt(in)	2.38															
1	32.07	0.37	0.00	0.00	0.00	0.00	0.00	0.00	18.61	0.25%	0.03			RO avg	ROSD	Aavg	ASD
2	32.07	0.00	12.70	533.42	0.00	0.00	0.00	0.00	185.50	2.45%	0.00	K0801M	NT	0.98%	1.27%	0.01	0.02
3	32.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.72	0.25%	0.00	2.38	TL	0.41%	0.31%	6.46	9.89
4	31.75	171.00	3.08	482.78	0.62	0.00	0.00	0.00	57.72	0.76%	17.87						
5	31.75	14.00	0.00	0.00	0.00	0.00	0.00	0.00	18.41	0.24%	1.11						
6	28.58	5.00	0.00	0.00	0.00	0.00	0.00	0.00	16.42	0.22%	0.40						

* Note that plots 1-3 are no-till and plots 4-6 are conventional till.

Plant Science Farm August 13, 1996

	PPt (in)	1.12															
Tobacco	B1		B2			B3			Tot	RO as	A						
Plot	d(cm)	soil(g)	d(cm)	bot(g)	soil(g)	d(cm)	bot(g)	soil(g)	RO(l)	%PPT	(kg/ha)						
1	32.07	0.26	6.99	520.56	0.03	0.00	0.00	0.00	108.90	3.05%	0.46			RO avg	ROSD	Aavg	ASD
2	31.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.41	0.52%	0.00	K0813B	NT	1.51%	1.35%	0.15	0.26
3	31.75	0.00	1.27	516.62	0.00	0.00	0.00	0.00	34.53	0.97%	0.00	1.12	TL	6.89%	1.62%	1.53	1.23
4	31.75	12.42	20.32	537.23	0.00	0.00	0.00	0.00	291.63	8.17%	0.99						
5	31.91	8.32	12.38	534.51	0.00	0.00	0.00	0.00	181.03	5.07%	0.66						
6	32.07	13.59	18.42	534.47	0.05	0.00	0.00	0.00	264.87	7.42%	2.94						
Tomatoes																	
Plot	PPt(in)	1.15															
1	32.07	0.19	0.64	397.31	0.00	0.00	0.00	0.00	26.66	0.73%	0.02			RO avg	ROSD	Aavg	ASD
2	29.21	0.00	0.32	182.46	0.00	0.00	0.00	0.00	20.86	0.57%	0.00	K0813M	NT	0.60%	0.11%	0.01	0.01
3	32.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.82	0.51%	0.00	1.15	TL	0.59%	0.14%	0.06	0.07
4	31.91	0.48	0.64	397.31	0.00	0.00	0.00	0.00	26.56	0.72%	0.04						
5	31.75	1.70	0.32	182.46	0.00	0.00	0.00	0.00	22.46	0.61%	0.14						
6	28.42	0.08	0.00	0.00	0.00	0.00	0.00	0.00	16.32	0.45%	0.01						

* Note that plots 1-3 are no-till and plots 4-6 are conventional till.

Plant Science Farm August 26, 1996

	PPt (in)	0.58															
Tobacco	B1		B2			B3			Tot	RO as	A						
Plot	d(cm)	soil(g)	d(cm)	bot(g)	soil(g)	d(cm)	bot(g)	soil(g)	RO(l)	%PPT	(kg/ha)						
1	31.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.06	0.98%	0.00			RO avg	ROSD	Aavg	ASD
2	31.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.32	0.99%	0.00	K0826B	NT	1.69%	1.23%	0.05	0.09
3	31.10	0.30	3.10	523.64	0.02	0.00	0.00	0.00	57.57	3.12%	0.15	0.58	TL	3.46%	1.59%	0.93	0.41
4	31.20	6.13	1.00	512.41	0.06	0.00	0.00	0.00	30.75	1.66%	0.61						
5	31.50	14.12	4.40	525.23	0.03	0.00	0.00	0.00	74.64	4.04%	1.39						
6	31.60	5.91	5.30	546.21	0.03	0.00	0.00	0.00	86.42	4.68%	0.78						
Tomatoes																	
Plot	PPt(in)	0.54															
1	31.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.25	1.06%	0.00			RO avg	ROSD	Aavg	ASD
2	31.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.25	1.06%	0.00	K0826M	NT	1.07%	0.01%	0.00	0.00
3	31.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.51	1.08%	0.00	0.54	TL	1.01%	0.06%	0.08	0.08
4	31.50	1.94	0.00	0.00	0.00	0.00	0.00	0.00	18.25	1.06%	0.15						
5	30.70	1.15	0.00	0.00	0.00	0.00	0.00	0.00	17.75	1.03%	0.09						
6	28.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.30	0.95%	0.00						

* Note that plots 1-3 are no-till and plots 4-6 are conventional till.

Plant Science Farm September 6, 1996

	PPt (in)	0.86									
Tobacco	B1		B2			B3			Tot	RO as	A
Plot	d(cm)	soil(g)	d(cm)	bot(g)	soil(g)	d(cm)	bot(g)	soil(g)	RO(l)	%PPT	(kg/ha)
1	31.6	0.22	7.00	533.42	0.00	0.00	0.00	0.00	108.73	3.97%	0.02
2	31.3	0.73	0.00	0.00	0.00	0.00	0.00	0.00	18.13	0.66%	0.06
3	31.4	0.81	0.00	0.00	0.00	0.00	0.00	0.00	18.19	0.66%	0.06
4	31.3	4.13	1.50	533.42	0.00	0.00	0.00	0.00	37.18	1.36%	0.33
5	31.8	37.09	8.00	589.34	0.08	0.00	0.00	0.00	122.09	4.46%	4.12
6	31.8	14.54	5.60	595.25	0.06	0.00	0.00	0.00	90.47	3.30%	1.77
Tomatoes											
Plot	PPt(in)	0.86									
1	31.1	0.00	3.30	533.42	0.00	0.00	0.00	0.00	60.15	2.20%	0.00
2	28.9	0.22	0.00	0.00	0.00	0.00	0.00	0.00	16.61	0.61%	0.02
3	31.9	0.11	0.00	0.00	0.00	0.00	0.00	0.00	18.51	0.68%	0.01
4	30.9	4.94	0.00	0.00	0.00	0.00	0.00	0.00	17.87	0.65%	0.39
5	31.4	1.25	0.00	0.00	0.00	0.00	0.00	0.00	18.19	0.66%	0.10
6	28.5	0.15	0.00	0.00	0.00	0.00	0.00	0.00	16.37	0.60%	0.01

		RO avg	ROSD	Aavg	ASD
K0906B	NT	1.76%	1.91%	0.05	0.03
0.86	TL	3.04%	1.57%	2.07	1.92

		RO avg	ROSD	Aavg	ASD
K0906M	NT	1.16%	0.90%	0.01	0.01
0.86	TL	0.64%	0.04%	0.17	0.20

* Note that plots 1-3 are no-till and plots 4-6 are conventional till.

Plant Science Farm September 18, 1996

	PPt (in)	1.14									
Tobacco	B1		B2			B3			Tot	RO as	A
Plot	d(cm)	soil(g)	d(cm)	bot(g)	soil(g)	d(cm)	bot(g)	soil(g)	RO(l)	%PPT	(kg/ha)
1	31.40	0.47	4.50	599.33	0.00	0.00	0.00	0.00	75.88	2.09%	0.04
2	31.60	0.60	0.00	0.00	0.00	0.00	0.00	0.00	18.32	0.50%	0.05
3	31.00	1.05	6.90	592.05	0.01	0.00	0.00	0.00	107.03	2.95%	0.21
4	31.70	9.45	4.20	580.57	0.07	0.00	0.00	0.00	72.17	1.99%	1.30
5	31.60	11.17	0.80	550.47	0.21	0.00	0.00	0.00	28.46	0.78%	1.22
6	31.00	85.61	2.10	541.75	0.06	0.00	0.00	0.00	44.66	1.23%	7.06
Tomatoes											
Plot	PPt(in)	1.11									
1	31.30	0.64	0.00	0.00	0.00	0.00	0.00	0.00	18.13	0.50%	0.05
2	31.60	1.88	1.10	533.42	0.00	0.00	0.00	0.00	32.27	0.89%	0.15
3	31.60	0.47	0.00	0.00	0.00	0.00	0.00	0.00	18.32	0.50%	0.04
4	31.40	4.81	0.00	0.00	0.00	0.00	0.00	0.00	18.19	0.50%	0.38
5	30.70	4.62	0.00	0.00	0.00	0.00	0.00	0.00	17.75	0.49%	0.37
6	28.00	0.69	1.00	533.42	0.00	0.00	0.00	0.00	28.74	0.79%	0.05

		RO avg	ROSD	Aavg	ASD
K0918B	NT	1.85%	1.24%	0.10	0.10
1.14	TL	1.33%	0.61%	3.19	3.35

		RO avg	ROSD	Aavg	ASD
K0918M	NT	0.63%	0.22%	0.08	0.06
1.11	TL	0.59%	0.17%	0.27	0.19

* Note that plots 1-3 are no-till and plots 4-6 are conventional till.

Plant Science Farm October 7, 1996

	PPt (in)	1.70															
Tobacco	B1		B2			B3			Tot	RO as	A						
Plot	d(cm)	soil(g)	d(cm)	bot(g)	soil(g)	d(cm)	bot(g)	soil(g)	RO(l)	%PPT	(kg/ha)						
1	31.30	0.24	12.10	615.48	0.02	0.00	0.00	0.00	176.84	3.26%	0.44			RO avg	ROSD	Aavg	ASD
2	30.90	0.22	11.00	530.28	0.03	0.00	0.00	0.00	161.68	2.99%	0.69	K1007B	NT	3.56%	0.77%	0.49	0.18
3	31.10	0.48	16.70	611.62	0.01	0.00	0.00	0.00	240.11	4.43%	0.33	1.7	TL	1.34%	0.24%	0.42	0.03
4	31.40	1.53	5.10	553.37	0.03	0.00	0.00	0.00	83.69	1.55%	0.42						
5	31.60	4.28	3.10	599.95	0.02	0.00	0.00	0.00	57.89	1.07%	0.45						
6	30.80	2.75	4.50	571.08	0.02	0.00	0.00	0.00	75.50	1.39%	0.39						
Tomatoes																	
Plot	PPt(in)	1.68															
1	31.50	1.69	0.00	0.00	0.00	0.00	0.00	0.00	18.25	0.34%	0.13			RO avg	ROSD	Aavg	ASD
2	31.20	0.97	1.20	472.23	0.02	0.00	0.00	0.00	33.29	0.61%	0.13	K1007M	NT	0.43%	0.16%	0.10	0.06
3	31.70	0.43	0.00	0.00	0.00	0.00	0.00	0.00	18.38	0.34%	0.03	1.68	TL	0.57%	0.40%	0.12	0.01
4	31.50	1.46	0.00	0.00	0.00	0.00	0.00	0.00	18.25	0.34%	0.12						
5	30.90	1.46	0.00	0.00	0.00	0.00	0.00	0.00	17.87	0.33%	0.12						
6	28.60	0.28	3.10	593.05	0.02	0.00	0.00	0.00	56.00	1.03%	0.14						

* Note that plots 1-3 are no-till and plots 4-6 are conventional till.

Plant Science Farm October 25, 1996

	PPt (in)	0.71									
Tobacco	B1		B2			B3			Tot	RO as	A
Plot	d(cm)	soil(g)	d(cm)	bot(g)	soil(g)	d(cm)	bot(g)	soil(g)	RO(l)	%PPT	(kg/ha)
1	31.60	1.48	3.70	577.30	0.14	0.00	0.00	0.00	65.63	2.90%	1.09
2	31.60	1.52	0.00	0.00	0.00	0.00	0.00	0.00	18.32	0.81%	0.12
3	31.50	1.91	2.50	581.36	0.06	0.00	0.00	0.00	50.11	2.22%	0.43
4	28.00	1.43	0.10	169.02	0.00	0.00	0.00	0.00	17.32	0.77%	0.11
5	31.60	3.20	1.50	432.23	0.19	0.00	0.00	0.00	37.37	1.65%	0.97
6	29.80	3.19	2.80	600.24	0.07	0.00	0.00	0.00	52.89	2.34%	0.61
Tomatoes											
Plot	PPt (in)	0.71									
1	31.70	1.03	0.00	0.00	0.00	0.00	0.00	0.00	18.38	0.81%	0.08
2	31.70	1.24	0.00	0.00	0.00	0.00	0.00	0.00	18.38	0.81%	0.10
3	31.90	1.14	0.00	0.00	0.00	0.00	0.00	0.00	18.51	0.82%	0.09
4	31.60	1.19	0.00	0.00	0.00	0.00	0.00	0.00	18.32	0.81%	0.09
5	31.40	1.90	0.00	0.00	0.00	0.00	0.00	0.00	18.19	0.80%	0.15
6	28.40	1.13	0.00	0.00	0.00	0.00	0.00	0.00	16.30	0.72%	0.09

		RO avg	ROSD	Aavg	ASD
B1025B	NT	1.98%	1.07%	0.55	0.49
0.71	TL	1.59%	0.79%	0.56	0.43

		RO avg	ROSD	Aavg	ASD
K1025M	NT	0.81%	0.00%	0.09	0.01
0.71	TL	0.78%	0.05%	0.11	0.03

* Note that plots 1-3 are no-till and plots 4-6 are conventional till.

Plant Science Farm November 4, 1996

	PPt (in)	0.72															
Tobacco	B1		B2			B3			Tot	RO as	A						
Plot	d(cm)	soil(g)	d(cm)	bot(g)	soil(g)	d(cm)	bot(g)	soil(g)	RO(l)	%PPT	(kg/ha)						
1	30.10	0.45	23.20	618.12	0.00	0.00	0.00	0.00	332.03	14.47%	0.04			RO avg	ROSD	Aavg	ASD
2	30.70	0.33	0.00	0.00	0.00	0.00	0.00	0.00	17.75	0.77%	0.03	K1104B	NT	5.34%	7.91%	0.03	0.01
3	30.50	0.49	0.00	0.00	0.00	0.00	0.00	0.00	17.62	0.77%	0.04	0.72	TL	1.55%	1.07%	0.13	0.09
4	30.50	1.05	0.00	0.00	0.00	0.00	0.00	0.00	17.62	0.77%	0.08						
5	31.00	0.79	0.60	354.49	0.00	0.00	0.00	0.00	25.54	1.11%	0.06						
6	32.50	1.33	3.50	596.46	0.02	0.00	0.00	0.00	63.62	2.77%	0.23						
Tomatoes																	
Plot	PPt (in)	0.70															
1	31.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00	17.94	0.78%	0.01			RO avg	ROSD	Aavg	ASD
2	26.60	0.36	0.00	0.00	0.00	0.00	0.00	0.00	15.19	0.66%	0.03	K1104M	NT	0.70%	0.07%	0.02	0.01
3	26.80	0.37	0.00	0.00	0.00	0.00	0.00	0.00	15.31	0.67%	0.03	0.7	TL	0.74%	0.06%	0.03	0.01
4	30.60	0.54	0.00	0.00	0.00	0.00	0.00	0.00	17.68	0.77%	0.04						
5	30.50	0.30	0.00	0.00	0.00	0.00	0.00	0.00	17.62	0.77%	0.02						
6	26.90	0.22	0.00	0.00	0.00	0.00	0.00	0.00	15.37	0.67%	0.02						

* Note that plots 1-3 are no-till and plots 4-6 are conventional till.

Plant Science Farm July 3, 1997

	PPt (in)	2.18															
Tobacco	B1		B2			B3			Tot	RO as	A						
Plot	d(cm)	soil(g)	d(cm)	bot(g)	soil(g)	d(cm)	bot(g)	soil(g)	RO(l)	%PPT	(kg/ha)						
1	31.8	22.71	31.7	527.43	0.08	3.90	496.61	0.04	1657.24	23.86%	15.12			RO avg	ROSD	Aavg	ASD
2	31.8	61.27	31.4	536.13	0.08	1.00	372.60	0.03	759.39	10.93%	11.99	K0703B	NT	57.98%	70.59%	47.87	59.45
3	31.4	73.54	31.3	549.99	0.11	27.90	556.05	0.08	9664.49	139.15%	116.48	2.18	TL	50.26%	57.21%	1012.46	623.28
4	31.7	2462.31	31.5	550.47	2.37	0.50	72.29	0.13	608.41	8.76%	365.43						
5	31.8	3481.19	30.2	553.99	5.90	23.30	550.91	0.90	8023.55	115.52%	1608.89						
6	31.8	5878.49	31.5	541.95	4.77	4.50	459.74	1.17	1840.97	26.51%	1063.06						
Tomatoes																	
Plot	PPt(in)	2.18															
1	31.5	75.3	12.5	474.79	0.11	0.00	0.00	0.00	182.41	2.63%	9.11			RO avg	ROSD	Aavg	ASD
2	28.9	7.69	9.2	509.14	0.05	0.00	0.00	0.00	136.24	1.96%	1.59	K0703M	NT	2.45%	0.43%	4.11	4.33
3	28.7	6.36	13.3	510.2	0.04	0.00	0.00	0.00	191.57	2.76%	1.63	2.18	TL	4.69%	2.20%	43.17	59.31
4	31.3	209.32	10.6	534.57	1.24	0.00	0.00	0.00	156.53	2.25%	43.17						
5	31.1	149.22	31.3	553.79	2.11	0.00	0.00	0.00	453.00	6.52%	140.47						
6	31.2	51.58	25.6	543.31	0.57	0.00	0.00	0.00	367.80	5.30%	33.07						

* Note that plots 1-3 are no-till and plots 4-6 are conventional till.

Plant Science Farm July 8, 1997

Tobacco	B1		B2			B3			Tot	RO as	A
	PPt (in)	0.67									
Plot	d(cm)	soil(g)	d(cm)	bot(g)	soil(g)	d(cm)	bot(g)	soil(g)	RO(l)	%PPT	(kg/ha)
1	31.12	4.87	1.43	538.35	0.09	0.00	0.00	0.00	36.17	1.69%	0.65
2	30.96	4.40	6.35	540.31	0.03	0.00	0.00	0.00	99.77	4.67%	0.73
3	30.80	9.05	6.03	540.65	0.08	0.00	0.00	0.00	95.47	4.47%	1.68
4	30.80	65181.79	29.85	550.95	1.64	0.00	0.00	0.00	430.85	20.18%	5282.03
5	29.85	42462.87	29.85	552.21	3.69	1.91	491.37	2.06	1013.31	47.47%	3800.89
6	30.80	33806.09	31.75	651.27	3.27	1.27	536.57	0.85	846.60	39.66%	2913.76
Tomatoes											
Plot	PPt(in)	0.68									
1	30.79	25.42	2.06	541.83	0.13	0.00	0.00	0.00	44.02	2.06%	2.56
2	29.53	1.04	1.27	264.33	0.02	0.00	0.00	0.00	33.13	1.55%	0.19
3	31.12	0.47	2.54	512.33	0.02	0.00	0.00	0.00	50.38	2.36%	0.14
4	30.79	134.18	7.62	536.81	1.01	0.00	0.00	0.00	116.41	5.45%	26.14
5	29.53	101.72	2.38	544.03	2.08	0.00	0.00	0.00	47.32	2.22%	17.91
6	30.96	29.81	0.00	0.00	0.00	0.00	0.00	0.00	17.91	0.84%	2.37

		RO avg	ROSD	Aavg	ASD
K0708B	NT	0.04	0.02	1.02	0.58
0.67	TL	0.36	0.14	3998.90	1196.49

		RO avg	ROSD	Aavg	ASD
K0708M	NT	0.02	0.00	0.96	1.38
0.68	TL	0.03	0.02	15.47	12.07

* Note that plots 1-3 are no-till and plots 4-6 are conventional till.

Plant Science Farm July 15, 1997

Tobacco	B1		B2			B3			Tot	RO as	A
Plot	d(cm)	soil(g)	d(cm)	bot(g)	soil(g)	d(cm)	bot(g)	soil(g)	RO(l)	%PPT	(kg/ha)
1	29.90	2.99	2.60	533.01	0.03	0.00	0.00	0.00	50.38	2.73%	0.40
2	29.80	2.83	5.20	519.46	0.00	0.00	0.00	0.00	83.98	4.54%	0.23
3	30.00	3.46	3.60	531.77	0.02	0.00	0.00	0.00	63.33	3.43%	0.42
4	30.00	76.24	5.00	519.39	1.50	0.00	0.00	0.06	81.50	4.41%	21.64
5	30.40	482.78	30.40	543.65	1.51	0.90	343.47	0.80	712.81	38.57%	183.71
6	30.60	902.99	17.50	541.45	1.88	0.00	0.00	0.00	250.99	13.58%	137.37
Tomatoes											
Plot	PPt(in)	0.65									
1	29.80	10.28	0.00	0.00	0.00	0.00	0.00	0.00	17.18	0.83%	0.82
2	27.90	2.40	0.70	128.57	0.00	0.00	0.00	0.00	24.86	1.20%	0.19
3	27.70	2.76	2.90	546.51	0.01	0.00	0.00	0.00	52.86	2.55%	0.28
4	30.00	53.15	3.60	546.13	0.19	0.00	0.00	0.00	63.33	3.06%	5.58
5	29.30	21.26	2.10	507.90	0.41	0.00	0.00	0.00	43.59	2.10%	3.52
6	30.20	3.23	2.20	547.83	0.08	0.00	0.00	0.00	45.44	2.19%	0.60

		RO avg	ROSD	Aavg	ASD
K0715B	NT	3.57%	0.92%	0.35	0.11
0.58	TL	18.86%	17.68%	114.24	83.48

		RO avg	ROSD	Aavg	ASD
K0715M	NT	1.53%	0.91%	0.43	0.34
0.65	TL	2.45%	0.53%	3.23	2.50

* Note that plots 1-3 are no-till and plots 4-6 are conventional till.

Plant Science Farm July 25, 1997

	PPt (in)	2.50									
Tobacco	B1		B2			B3			Tot	RO as	A
Plot	d(cm)	soil(g)	d(cm)	bot(g)	soil(g)	d(cm)	bot(g)	soil(g)	RO(l)	%PPT	(kg/ha)
1	31.80	25.12	31.50	544.55	0.10	1.50	532.14	0.06	913.82	11.47%	12.61
2	31.90	14.50	31.40	544.33	0.13	5.70	535.07	0.07	2215.07	27.81%	28.54
3	31.60	5.93	31.60	536.95	0.06	34.20	550.85	0.09	11965.11	150.22%	148.89
4	31.20	37746.66	31.40	547.09	1.51	1.30	520.95	0.71	850.70	10.68%	3142.64
5	30.60	57403.61	31.50	549.61	2.53	17.80	541.11	0.88	6156.35	77.29%	5472.87
6	31.50	82093.54	28.50	543.93	5.18	3.20	552.25	1.41	1391.68	17.47%	7035.92
Tomatoes											
Plot	PPt(in)	2.59									
1	31.90	59.54	28.30	545.43	0.04	0.00	0.00	0.00	408.28	4.95%	6.98
2	28.00	4.53	31.00	524.05	0.04	2.70	525.21	0.04	1272.68	15.42%	8.23
3	30.80	8.11	28.90	542.89	0.10	0.00	0.00	0.00	416.57	5.05%	6.39
4	31.10	157.11	31.50	556.17	0.60	0.00	0.00	0.00	456.04	5.53%	49.14
5	30.70	56.86	14.50	510.97	0.73	0.00	0.00	0.00	209.32	2.54%	26.86
6	31.20	22.95	28.70	548.01	0.51	0.00	0.00	0.00	413.82	5.01%	30.63

		RO avg	ROSD	Aavg	ASD
K0725B	NT	63.17%	75.83%	63.35	74.51
2.5	TL	35.15%	36.66%	5217.14	1959.20

		RO avg	ROSD	Aavg	ASD
K0725M	NT	8.47%	6.02%	7.20	0.94
2.59	TL	4.36%	1.60%	35.54	11.93

* Note that plots 1-3 are no-till and plots 4-6 are conventional till.

Plant Science Farm August 15, 1997

	PPt (in)	0.24									
Tobacco	B1		B2			B3			Tot	RO as	A
Plot	d(cm)	soil(g)	d(cm)	bot(g)	soil(g)	d(cm)	bot(g)	soil(g)	RO(l)	%PPT	(kg/ha)
1	28.80	0.60	0.00	0.00	0.00	0.00	0.00	0.00	16.55	2.16%	0.05
2	24.80	0.50	0.00	0.00	0.00	0.00	0.00	0.00	14.08	1.84%	0.04
3	17.00	0.26	0.00	0.00	0.00	0.00	0.00	0.00	9.43	1.23%	0.02
4	32.10	4.99	0.00	0.00	0.00	0.00	0.00	0.00	18.63	2.44%	0.40
5	22.00	1.11	0.00	0.00	0.00	0.00	0.00	0.00	12.39	1.62%	0.09
6	14.70	9.72	0.00	0.00	0.00	0.00	0.00	0.00	8.10	1.06%	0.77
Tomatoes											
Plot	PPt(in)	0.24									
1	13.60	0.99	0.00	0.00	0.00	0.00	0.00	0.00	7.47	0.98%	0.08
2	6.50	0.17	0.00	0.00	0.00	0.00	0.00	0.00	3.49	0.46%	0.01
3	15.20	0.10	0.00	0.00	0.00	0.00	0.00	0.00	8.39	1.10%	0.01
4	18.60	0.71	0.00	0.00	0.00	0.00	0.00	0.00	10.37	1.36%	0.06
5	11.70	0.57	0.00	0.00	0.00	0.00	0.00	0.00	6.39	0.84%	0.05
6	8.10	0.32	0.00	0.00	0.00	0.00	0.00	0.00	4.37	0.57%	0.03

		RO avg	ROSD	Aavg	ASD
K0815B	NT	1.75%	0.47%	0.03	0.01
0.24	TL	1.71%	0.69%	0.42	0.34

		RO avg	ROSD	Aavg	ASD
K0815M	NT	0.84%	0.34%	0.03	0.04
0.24	TL	0.92%	0.40%	0.04	0.02

* Note that plots 1-3 are no-till and plots 4-6 are conventional till.

Plant Science Farm August 22, 1997

Tobacco	PPt (in)	0.76									
	B1		B2			B3			Tot	RO as	A
Plot	d(cm)	soil(g)	d(cm)	bot(g)	soil(g)	d(cm)	bot(g)	soil(g)	RO(l)	%PPT	(kg/ha)
1	31.8	6.83	32.20	538.57	0.02	1.40	515.89	0.02	893.88	36.92%	3.24
2	31.9	0.97	3.70	470.92	0.01	0.00	0.00	0.00	65.82	2.72%	0.16
3	31.7	4.32	4.70	527.81	0.03	0.00	0.00	0.00	78.67	3.25%	0.63
4	31.6	20.01	4.20	508.87	0.31	0.00	0.00	0.00	72.11	2.98%	4.35
5	30.7	123.66	12.30	533.59	0.49	0.00	0.00	0.00	179.18	7.40%	22.02
6	31.5	231.13	18.00	539.23	0.99	0.00	0.00	0.00	258.59	10.68%	54.03
Tomatoes											
Plot	PPt(in)	0.79									
1	31.9	7.52	0.00	0.00	0.00	0.00	0.00	0.00	18.51	0.76%	0.60
2	29	0.07	0.80	201.84	0.02	0.00	0.00	0.00	26.82	1.11%	0.09
3	28.6	1.04	0.00	0.00	0.00	0.00	0.00	0.00	16.43	0.68%	0.08
4	31.7	23.47	2.40	524.66	0.14	0.00	0.00	0.00	48.95	2.02%	2.56
5	31.6	31.49	0.00	0.00	0.00	0.00	0.00	0.00	18.32	0.76%	2.51
6	na	na	na	na	na	na	na	na	na	na	na

		RO avg	ROSD	Aavg	ASD
K0822B	NT	14.29%	19.59%	1.34	1.66
0.76	TL	7.02%	3.86%	26.80	25.18

		RO avg	ROSD	Aavg	ASD
K0822M	NT	0.85%	0.23%	0.26	0.30
0.785	TL	1.39%	0.89%	2.53	0.04

* Note that plots 1-3 are no-till and plots 4-6 are conventional till.
* Note that na indicates that data was not available.

Plant Science Farm September 16, 1997

	PPt (In)	0.49									
Tobacco	B1		B2			B3			Tot	RO as	A
Plot	d(cm)	soil(g)	d(cm)	bot(g)	soil(g)	d(cm)	bot(g)	soil(g)	RO(l)	%PPT	(kg/ha)
1	30.70	1.20	2.80	535.65	0.00	0.00	0.00	0.00	53.46	3.42%	0.10
2	31.30	0.58	2.70	529.54	0.01	0.00	0.00	0.00	52.55	3.37%	0.10
3	31.40	0.96	1.50	295.50	0.01	0.00	0.00	0.00	37.24	2.39%	0.13
4	30.90	17.22	1.40	321.70	0.08	0.00	0.00	0.00	35.65	2.28%	1.75
5	30.50	46.96	5.90	519.47	0.20	0.00	0.00	0.00	93.57	5.99%	6.19
6	31.00	165.45	3.70	505.68	0.84	0.00	0.00	0.00	65.25	4.18%	19.79
Tomatoes											
Plot	PPt(In)	0.51									
1	31.50	5.65	0.00	0.00	0.00	0.00	0.00	0.00	18.25	1.17%	0.45
2	20.60	0.68	0.00	0.00	0.00	0.00	0.00	0.00	11.55	0.74%	0.05
3	29.00	0.31	0.00	0.00	0.00	0.00	0.00	0.00	16.68	1.07%	0.02
4	31.30	12.37	0.50	87.54	0.00	0.00	0.00	0.00	24.46	1.57%	0.98
5	29.20	11.93	0.00	0.00	0.00	0.00	0.00	0.00	16.80	1.08%	0.95
6	na	na	na	na	na	na	na	na	na	na	na

		RO avg	ROSD	Aavg	ASD
K0916B	NT	3.06%	0.58%	0.11	0.02
0.49	TL	4.15%	1.86%	9.24	9.40

		RO avg	ROSD	Aavg	ASD
K0916M	NT	0.99%	0.22%	0.18	0.24
0.51	TL	1.32%	0.35%	0.97	0.02

* Note that plots 1-3 are no-till and plots 4-6 are conventional till.
* Note that na indicates data that was not available.

Plant Science Farm October 1, 1997

	PPt (in)	1.90									
Tobacco	B1		B2			B3			Tot	RO as	A
Plot	d(cm)	soil(g)	d(cm)	bot(g)	soil(g)	d(cm)	bot(g)	soil(g)	RO(l)	%PPT	(kg/ha)
1	32.00	0.82	14.10	545.07	0.01	0.00	0.00	0.00	204.63	3.38%	0.34
2	30.90	0.38	30.90	531.59	0.00	0.00	0.00	0.00	446.60	7.38%	0.03
3	31.80	2.49	15.00	538.63	0.00	0.00	0.00	0.00	216.92	3.58%	0.20
4	31.50	12.64	12.50	519.37	0.04	0.00	0.00	0.00	182.41	3.01%	2.04
5	31.80	24.77	11.60	532.76	0.25	0.00	0.00	0.00	170.37	2.81%	7.84
6	32.00	241.06	19.00	529.30	0.43	0.00	0.00	0.00	273.03	4.51%	35.82
Tomatoes											
Plot	PPt(in)	1.89									
1	31.70	2.72	0.00	0.00	0.00	0.00	0.00	0.00	18.38	0.30%	0.22
2	31.30	0.40	8.10	509.94	0.02	0.00	0.00	0.00	123.10	2.03%	0.37
3	31.00	0.44	0.00	0.00	0.00	0.00	0.00	0.00	17.94	0.30%	0.04
4	31.40	9.71	1.00	256.73	0.01	0.00	0.00	0.00	30.87	0.51%	0.81
5	31.50	8.11	0.00	0.00	0.00	0.00	0.00	0.00	18.25	0.30%	0.65
6	na	na	na	na	na	na	na	na	na	na	na

		RO avg	ROSD	Aavg	ASD
K1001B	NT	4.78%	2.25%	0.19	0.16
1.9	TL	3.45%	0.93%	15.24	18.06

		RO avg	ROSD	Aavg	ASD
K1001M	NT	0.88%	1.00%	0.21	0.17
1.89	TL	0.41%	0.15%	0.73	0.12

* Note that plots 1-3 are no-till and plots 4-6 are conventional till.
* Note that na indicates data that was not available.

Grove Farm August 14, 1996

	PPt (in)	2.06															
Tomatoes	B1		B2			B3			Tot	RO as	A						
Plot	d(cm)	soil(g)	d(cm)	bot(g)	soil(g)	d(cm)	bot(g)	soil(g)	RO(l)	%PPT	(kg/ha)						
1	31.75	11.98	29.21	533.42	0.00	0.00	0.00	0.00	421.82	6.43%	0.95			RO avg	ROSD	Aavg	ASD
3	32.07	47.06	31.59	542.61	0.66	0.00	0.00	0.00	458.03	6.98%	45.18	C0814M	NT	6.70%	0.39%	23.07	31.27
5	32.23	2944.00	31.12	560.53	10.71	2.38	611.16	0.66	1178.55	17.96%	941.93	2.06	TL	12.36%	7.92%	957.49	22.00
6	31.91	2381.00	30.64	553.19	13.12	0.00	0.00	0.00	443.50	6.76%	973.05						

* Note that plots 1and 3 are no-till and plots 5 and 6 are conventional till.

Grove Farm September 5, 1996.

	PPt (in)	1.50															
Tomatoes	B1		B2			B3			Tot	RO as	A						
Plot	d(cm)	soil(g)	d(cm)	bot(g)	soil(g)	d(cm)	bot(g)	soil(g)	RO(l)	%PPT	(kg/ha)						
1	29.50	29.26	28.00	587.07	4.32	0.00	0.00	0.00	402.29	8.42%	224.50			RO avg	ROSD	Aavg	ASD
3	31.50	43.17	31.00	594.14	4.91	7.30	597.26	4.47	2713.69	56.78%	1693.60	C0905M	NT	32.60%	34.20%	959.05	1038.81
5	31.50	787.74	31.30	594.25	9.35	5.00	593.82	7.17	1993.89	41.72%	2156.13	1.50	TL	40.33%	1.96%	2194.38	54.10
6	31.20	1796.02	30.80	612.88	11.99	4.60	581.18	7.03	1861.14	38.94%	2232.64						

* Note that plots 1and 3 are no-till and plots 5 and 6 are conventional till.

Grove Farm September 25, 1996

PPt (in) 1.33

Tomatoes	B1		B2			B3			Tot	RO as	A
Plot	d(cm)	soil(g)	d(cm)	bot(g)	soil(g)	d(cm)	bot(g)	soil(g)	RO(l)	%PPT	(kg/ha)
1	29.40	8.88	2.00	557.92	0.01	0.00	0.00	0.00	42.37	1.00%	0.75
3	31.80	30.79	9.30	526.62	0.00	0.00	0.00	0.00	139.40	3.29%	2.45
5	32.50	1575.82	27.50	597.06	1.22	0.00	0.00	0.00	396.73	9.36%	185.97
6	31.70	2067.31	9.20	582.44	1.56	0.00	0.00	0.00	138.00	3.26%	191.06

		RO avg	ROSD	Aavg	ASD
C0925M	NT	2.14%	1.62%	1.60	1.21
1.33	TL	6.31%	4.32%	188.52	3.59

* Note that plots 1 and 3 are no-till and plots 5 and 6 are conventional till.

Grove Farm September 30, 1996

PPt (in) 1.21

Tomatoes	B1		B2			B3			Tot	RO as	A
Plot	d(cm)	soil(g)	d(cm)	bot(g)	soil(g)	d(cm)	bot(g)	soil(g)	RO(l)	%PPT	(kg/ha)
1	28.60	0.20	5.00	0.00	0.00	0.00	0.00	0.00	80.62	2.09%	0.02
3	31.40	1.21	3.80	0.00	0.00	0.00	0.00	0.00	66.80	1.73%	0.10
5	31.20	158.33	1.20	0.00	0.00	0.00	0.00	0.00	33.29	0.86%	12.60
6	31.00	327.84	3.60	0.00	0.00	0.00	0.00	0.00	63.96	1.66%	26.08

		RO avg	ROSD	Aavg	ASD
C0930M	NT	1.91%	0.25%	0.06	0.06
1.21	TL	1.26%	0.56%	19.34	9.54

* Note that plots 1 and 3 are no-till and plots 5 and 6 are conventional till.

Grove Farm November 7, 1996

	PPt (in)	1.90															
Tomatoes	B1		B2			B3			Tot	RO as	A						
Plot	d(cm)	soil(g)	d(cm)	bot(g)	soil(g)	d(cm)	bot(g)	soil(g)	RO(l)	%PPT	(kg/ha)						
1	32.50	4.58	0.00	0.00	0.00	0.00	0.00	0.00	18.89	0.31%	0.36						
3	32.10	8.04	7.10	560.90	0.05	0.00	0.00	0.00	110.37	1.82%	1.32			RO avg	ROSD	Aavg	ASD
5	31.70	280.29	29.20	591.06	0.63	0.00	0.00	0.00	421.64	6.97%	55.86	C1107M	NT	1.07%	1.07%	0.84	0.68
6	31.70	926.62	16.80	608.50	1.43	0.00	0.00	0.00	241.89	4.00%	116.30	1.9	TL	5.48%	2.10%	86.08	42.74

* Note that plots 1 and 3 are no-till and plots 5 and 6 are conventional till.

Grove Farm July 9, 1997

	PPt (in)	0.25									
Tobacco	B1		B2			B3			Tot	RO as	A
Plot	d(cm)	soil(g)	d(cm)	bot(g)	soil(g)	d(cm)	bot(g)	soil(g)	RO(l)	%PPT	(kg/ha)
1	27.50	6.47	0.00	0.00	0.00	0.00	0.00	0.00	15.74	1.98%	0.51
2	28.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	16.05	2.02%	0.40
3	28.60	13.24	0.00	0.00	0.00	0.00	0.00	0.00	16.43	2.06%	1.05
4	29.80	39.74	0.00	0.00	0.00	0.00	0.00	0.00	17.18	2.16%	3.16
5	30.80	58.29	0.00	0.00	0.00	0.00	0.00	0.00	17.81	2.24%	4.64
6	28.30	78.38	2.40	540.59	0.40	0.00	0.00	0.00	46.81	5.88%	8.15

		RO avg	ROSD	Aavg	ASD
C0709B	NT	2.02%	0.04%	0.66	0.35
0.25	TL	3.42%	2.13%	5.32	2.56

* Note that plots 1-3 are no-till and plots 4-6 are conventional till.

Grove Farm July 28, 1997

	PPt (in)	0.99									
Tobacco	B1		B2			B3			Tot	RO as	A
Plot	d(cm)	soil(g)	d(cm)	bot(g)	soil(g)	d(cm)	bot(g)	soil(g)	RO(l)	%PPT	(kg/ha)
1	32.70	6.34	5.20	540.11	0.05	0.00	0.00	0.00	85.82	2.72%	1.02
2	32.20	15.81	6.90	462.91	0.06	0.00	0.00	0.00	107.79	3.42%	2.22
3	29.60	27.46	1.80	230.91	0.18	0.00	0.00	0.00	39.94	1.27%	3.70
4	31.10	433.13	28.10	555.83	1.49	0.00	0.00	0.00	404.79	12.83%	115.69
5	32.6	282.72	28.5	528.91	1.54	0.00	0.00	0.00	411.72	13.05%	111.98
6	31.9	744.62	27.4	541.2	5.48	0.00	0.00	0.00	394.86	12.52%	358.42

		RO avg	ROSD	Aavg	ASD
C0728B	NT	2.47%	1.10%	2.31	1.34
0.99	TL	12.80%	0.27%	195.36	141.22

* Note that plots 1-3 are no-till and plots 4-6 are conventional till.

Grove Farm August 8, 1997

	PPt (in)	0.50									
Tobacco	B1		B2			B3			Tot	RO as	A
Plot	d(cm)	soil(g)	d(cm)	bot(g)	soil(g)	d(cm)	bot(g)	soil(g)	RO(l)	%PPT	(kg/ha)
1	29.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.74	1.05%	0.00
2	31.70	0.00	1.50	423.79	0.03	0.00	0.00	0.00	37.43	2.35%	0.11
3	29.80	10.24	1.00	281.78	0.02	0.00	0.00	0.00	29.86	1.87%	0.89
4	31.40	77.54	4.80	526.55	1.31	0.00	0.00	0.00	79.78	5.01%	19.05
5	31.2	96.33	5.1	521.71	0.56	0.00	0.00	0.00	83.56	5.25%	13.57
6	31.2	240.03	15.5	549.93	3.12	0.00	0.00	0.00	223.47	14.03%	113.92

		RO avg	ROSD	Aavg	ASD
C0808B	NT	1.76%	0.66%	0.34	0.48
0.50	TL	8.09%	5.14%	48.85	56.43

* Note that plots 1-3 are no-till and plots 4-6 are conventional till.

Grove Farm August 25, 1997

	PPt (in)	1.27									
Tobacco	B1		B2			B3			Tot	RO as	A
Plot	d(cm)	soil(g)	d(cm)	bot(g)	soil(g)	d(cm)	bot(g)	soil(g)	RO(l)	%PPT	(kg/ha)
1	27.80	3.39	0.00	0.00	0.00	0.00	0.00	0.00	15.93	0.39%	0.27
2	31.70	3.43	0.00	0.00	0.00	0.00	0.00	0.00	18.38	0.45%	0.27
3	31.40	9.75	4.20	497.94	0.03	0.00	0.00	0.00	71.98	1.78%	1.05
4	31.30	42.25	8.00	525.18	0.64	0.00	0.00	0.00	121.77	3.01%	13.87
5	31.6	195.19	16.4	519.44	0.42	0.00	0.00	0.00	236.24	5.84%	29.83
6	30.8	188.73	28.00	539.59	1.64	0.00	0.00	0.00	403.10	9.96%	106.78

		RO avg	ROSD	Aavg	ASD
C0825B	NT	0.88%	0.78%	0.53	0.45
1.27	TL	6.27%	3.50%	50.16	49.68

* Note that plots 1-3 are no-till and plots 4-6 are conventional till.

Grove Farm September 11, 1997

PPt (in) 0.36

Tobacco Plot	B1 d(cm)	soil(g)	B2 d(cm)	bot(g)	soil(g)	B3 d(cm)	bot(g)	soil(g)	Tot RO(l)	RO as %PPT	A (kg/ha)
1	29.40	1.11	0.00	0.00	0.00	0.00	0.00	0.00	16.93	1.48%	0.09
2	26.80	0.86	0.00	0.00	0.00	0.00	0.00	0.00	15.31	1.33%	0.07
3	27.50	1.24	0.00	0.00	0.00	0.00	0.00	0.00	15.74	1.37%	0.10
4	14.50	2.06	0.00	0.00	0.00	0.00	0.00	0.00	7.98	0.70%	0.16
5	32.70	3.67	0.00	0.00	0.00	0.00	0.00	0.00	19.02	1.66%	0.29
6	30.20	3.28	0.00	0.00	0.00	0.00	0.00	0.00	17.43	1.52%	0.26

		RO avg	ROSD	Aavg	ASD
C0911B	NT	1.39%	0.07%	0.09	0.02
0.36	TL	1.29%	0.52%	0.24	0.07

* Note that plots 1-3 are no-till and plots 4-6 are conventional till.

Grove Farm October 2, 1997

PPt (in) 2.87

Tobacco Plot	B1 d(cm)	soil(g)	B2 d(cm)	bot(g)	soil(g)	B3 d(cm)	bot(g)	soil(g)	Tot RO(l)	RO as %PPT	A (kg/ha)
1	28.40	1.01	0.00	0.00	0.00	0.00	0.00	0.00	16.30	0.18%	0.08
2	31.80	4.49	11.70	531.97	0.00	0.00	0.00	0.00	171.72	1.88%	0.36
3	31.80	12.32	2.50	508.08	0.10	0.00	0.00	0.00	50.30	0.55%	1.51
4	31.70	55.42	1.70	440.32	0.51	0.00	0.00	0.00	39.99	0.44%	6.53
5	32.00	47.93	13.00	524.67	0.83	0.00	0.00	0.00	189.55	2.07%	25.99
6	31.40	93.62	28.40	530.69	0.91	0.00	0.00	0.00	409.46	4.48%	59.96

		RO avg	ROSD	Aavg	ASD
C1002B	NT	1.39%	0.07%	0.09	0.02
2.87	TL	1.29%	0.52%	0.24	0.07

* Note that plots 1-3 are no-till and plots 4-6 are conventional till.

Appendix D.

Nutrient Loss Data

Appendix D

Nomenclature

N	nitrogen
na	not available
ND	none detected
NO_2	nitrite
NO_3	nitrate
P	phosphorus
PO_4	orthophosphate
Ppt	precipitation
RO	runoff
TKN	total Kjeldahl nitrogen
TKP	total Kjeldahl phosphorus

Plant Science Farm July 3, 1997

Tobacco	PPt(in) Soil TKP	2.18 Soil TKP	RO TKP	RO PO4	RO P Total	Soil TKN	Soil TKN	RO TKN	NO2	NO3	RO N Total
Plot	mg P/L	% P	mg P/L	mg P/L	mg P/L	mg N/L	% N	mg N/L	mg N/L	mg N/L	mg N/L
1	1.66	0.028	0.16	0.473	0.633	33.74	0.562	3.241	ND	3.748	6.989
2	1.48	0.025	ND	0.297	0.297	32	0.533	2.696	ND	4.098	6.794
3	1.12	0.019	0.25	1.041	1.291	54.97	0.916	3.079	ND	2.405	5.484
4	1.6	0.027	ND	ND	0	33.17	0.553	2.227	ND	6.822	9.049
5	1.16	0.019	ND	ND	0	84.6	1.410	3.851	ND	10.37	14.221
6	0.92	0.015	ND	ND	0	68.98	1.150	2.325	ND	6.495	8.82
Tomatoes											
Plot	PPt(in)	2.18									
1	2.02	0.034	ND		0	130.68	2.178	0.418	ND	1.447	1.865
2	2.76	0.046	0.12	0.63	0.75	40.54	0.676	1.757	ND	8.22	9.977
3	3.11	0.052	ND	0.316	0.316	49.65	0.828	2.274	ND	1.72	3.994
4	1.95	0.033	ND	ND	0	131.77	2.196	1.07	0.207	0.741	2.018
5	1.96	0.033	ND	ND	0	39.5	0.658	1.089	ND	0.957	2.046
6	2.37	0.040	ND	ND	0	35.43	0.591	0.788	0.153	0.468	1.409

Tobacco	Total Soil	Total RO	Total P	Total PO4	Total Soil	Total RO	Total N	Total NO2	Total NO3	Total NO2 + NO3
Plot	TKP (mg)	P (mg)	mg	mg	TKN (mg)	N (mg)	mg	mg	mg	mg
1	66.19	1049.04	1115.23	783.88	1329.36	11582.47	12911.83	0.00	6211.35	6211.35
2	46.25	225.54	271.79	225.54	999.91	5159.32	6159.23	0.00	3111.99	3111.99
3	339.93	12476.85	12816.78	10060.73	16683.88	53000.05	69683.93	0.00	23243.09	23243.09
4	1523.45	0.00	1523.45	0.00	31583.03	5505.49	37088.52	0.00	4150.56	4150.56
5	4862.87	0.00	4862.87	0.00	354654.37	114102.89	468757.26	0.00	83204.20	83204.20
6	2548.33	0.00	2548.33	0.00	191069.17	16237.32	207306.49	0.00	11957.07	11957.07
Tomatoes										
Plot										
1	47.97	0.00	47.97	0.00	3103.35	340.19	3443.55	0.00	263.95	263.95
2	11.41	102.18	113.58	85.83	167.54	1359.24	1526.78	0.00	1119.87	1119.87
3	13.21	60.54	73.75	60.54	210.93	765.15	976.08	0.00	329.51	329.51
4	219.33	0.00	219.33	0.00	14821.41	315.89	15137.30	32.40	115.99	148.39
5	717.37	0.00	717.37	0.00	14457.25	926.84	15384.09	0.00	433.52	433.52
6	204.19	0.00	204.19	0.00	3052.45	518.22	3570.67	56.27	172.13	228.40

* Note plots 1-3 are no-till and plots 4-6 are conventional till.

* Note ND means none detected.

* Note that a missing value indicates that there was not enough sample for analysis.

Plant Science Farm July 8, 1997

	PPt (in)	0.67									
Tobacco	Soil TKP	Soil TKP	RO TKP	RO PO4	RO P Total	Soil TKN	Soil TKN	RO TKN	NO2	NO3	RO 'N Total
Plot	mg P/L	% P	mg P/L	mg P/L	mg P/L	mg N/L	% N	mg N/L	mg N/L	mg N/L	mg N/L
1	2.34	0.039	0.19	0.33	0.516	188.99	3.150	4.435	ND	5.73	10.163
2	2.56	0.043	ND	ND	0	39.47	0.658	3.274	ND	5.44	8.711
3	1.59	0.027	0.23	0.93	1.156	139.88	2.331	3.690	ND	6.05	9.737
4	1.08	0.018	ND	ND	0	90.42	1.507	3.459	ND	1.24	4.702
5	1.05	0.018	ND	ND	0	78.29	1.305	3.886	ND	1.36	5.248
6	0.79	0.013	ND	ND	0	64.33	1.072	5.594	ND	1.73	7.326
Tomatoes											
Plot	PPt(in)	0.68									
1	1.89	0.032	ND	ND	0	127.49	2.125	2.192	ND	128.20%	3.474
2	2.81	0.047	ND	ND	0	175.19	2.920	1.206	0.270	120.20%	2.678
3	0.84	0.014	ND	ND	0	248.62	4.144	1.069	ND	78.40%	1.873
4	0.96	0.016	ND	ND	0	74.61	1.244	2.024	ND	112.70%	3.151
5	2.06	0.034	0.15	ND	0.15	145.17	2.420	0.621	ND	143.70%	2.058
6	2.39	0.040	ND	ND	0	38.85	0.648	1.277	ND	119.60%	2.473

Tobacco	Total Soil	Total RO	Total P	Total PO4	Total Soil	Total RO	Total N	Total NO2	Total NO3	Total NO2 + NO3
Plot	TKP (mg)	P (mg)	mg	mg	TKN (mg)	N (mg)	mg	mg	mg	mg
1	3.93	18.67	22.60	11.79	317.75	367.63	685.38	0.00	207.20	207.20
2	4.87	0.00	4.87	0.00	75.10	869.08	944.18	0.00	542.44	542.44
3	6.97	110.36	117.33	88.40	613.12	929.56	1542.68	0.00	577.29	577.29
4	14863.90	0.00	14863.90	0.00	1244439.11	2025.88	1246464.99	0.00	535.55	535.55
5	10398.80	0.00	10398.80	0.00	775354.08	5317.86	780671.94	0.00	1380.13	1380.13
6	5997.77	0.00	5997.77	0.00	488400.40	6202.20	494602.60	0.00	1466.31	1466.31
Tomatoes										
Plot										
1	12.58	0.00	12.58	0	848.91	152.91	1001.82	0.00	56.43	56.43
2	1.36	0.00	1.36	0	85.07	88.73	173.80	8.95	39.82	48.77
3	0.32	0.00	0.32	0	93.49	94.36	187.85	0.00	39.50	39.50
4	65.38	0.00	65.38	0	5080.91	366.81	5447.72	0.00	131.19	131.19
5	96.11	7.10	103.21	0	6772.87	97.39	6870.26	0.00	68.01	68.01
6	14.77	0.00	14.77	0	240.10	44.29	284.39	0.00	21.42	21.42

* Note plots 1-3 are no-till and plots 4-6 are conventional till.
* Note ND indicates none detected.
* Note that a missing value indicates that there was not enough sample for analysis.

Plant Science Farm July 15, 1997

	PPt (in)	0.58									
Tobacco	Soil TKP	Soil TKP	RO TKP	RO PO4	RO P Total	Soil TKN	Soil TKN	RO TKN	NO2	NO3	RO 'N Total
Plot	mg P/L	% P	mg P/L	mg P/L	mg P/L	mg N/L	% N	mg N/L	mg N/L	mg N/L	mg N/L
1	1.68	0.028	0.03	ND	0.03	173.83	2.897	1.016	ND	0.728	1.744
2	1.94	0.032	ND	ND	0	241.20	4.020	1.502	0.272	0.472	2.246
3	1.86	0.031	ND	ND	0	193.94	3.232	0.544	0.267	0.750	1.561
4	1.11	0.019	ND	ND	0	99.16	1.653	3.841	ND	1.214	5.055
5	1.07	0.018	ND	ND	0	90.88	1.515	3.049	ND	1.253	4.302
6	0.86	0.014	ND	ND	0	65.46	1.091	1.895	ND	1.197	3.092
Tomatoes											
Plot	PPt(in)	0.65									
1	2.05	0.034	ND	ND	0	149.32	2.489	1.357	ND	0.904	2.261
2	2.50	0.042	ND	ND	0	260.77	4.346	2.164	0.229	0.775	3.168
3	2.64	0.044	ND	ND	0	215.77	3.596	1.505	ND	0.593	2.098
4	2.25	0.038	ND	ND	0	254.02	4.234	1.094	0.241	0.776	2.111
5	2.11	0.035	ND	ND	0	27.17	0.453	2.476	ND	1.231	3.707
6	2.35	0.039	ND	ND	0	35.50	0.592	2.128	0.300	0.937	3.365

Tobacco	Total Soil	Total RO	Total P	Total PO4	Total Soil	Total RO	Total N	Total NO2	Total NO3	Total NO2 + NO3
Plot	TKP (mg)	P (mg)	mg	mg	TKN (mg)	N (mg)	mg	mg	mg	mg
1	1.73	1.51	3.24	0.00	179.23	87.86	267.09	0.00	36.68	36.68
2	1.14	0.00	1.14	0.00	141.51	188.62	330.13	22.84	39.64	62.48
3	2.04	0.00	2.04	0.00	212.89	98.86	311.75	16.91	47.50	64.41
4	62.58	0.00	62.58	0.00	5590.38	411.97	6002.35	0.00	98.94	98.94
5	512.19	0.00	512.19	0.00	43502.57	3066.51	46569.09	0.00	893.15	893.15
6	307.82	0.00	307.82	0.00	23429.93	776.07	24206.00	0.00	300.44	300.44
Tomatoes										
Plot										
1	4.37	0.00	4.37	0.00	318.23	38.84	357.07	0.00	15.53	15.53
2	1.24	0.00	1.24	0.00	129.75	78.77	208.51	5.69	19.27	24.96
3	1.90	0.00	1.90	0.00	155.63	110.91	266.54	0.00	31.35	31.35
4	32.71	0.00	32.71	0.00	3692.89	133.69	3826.58	15.26	49.14	64.41
5	19.35	0.00	19.35	0.00	249.16	161.59	410.76	0.00	53.66	53.66
6	3.69	0.00	3.69	0.00	55.82	152.90	208.71	13.63	42.57	56.21

* Note plots 1-3 are no-till and plots 4-6 are conventional till.

* Note ND indicates none detected.

* Note that a missing value indicates that there was not enough sample for analysis.

Plant Science Farm July 25, 1997

	PPt (in)	2.50									
Tobacco	Soil TKP	Soil TKP	RO TKP	RO PO4	RO P Total	Soil TKN	Soil TKN	RO TKN	NO2	NO3	RO 'N Total
Plot	mg P/L	% P	mg P/L	mg P/L	mg P/L	mg N/L	% N	mg N/L	mg N/L	mg N/L	mg N/L
1	1.18	0.020	ND	ND	0	122.02	2.034	3.928	ND	ND	3.928
2	0.67	0.011	ND	ND	0	30.18	0.503	4.119	1.683	ND	5.802
3	0.97	0.016	0.03	0.612	0.642	26.99	0.450	5.788	ND	2.059	7.847
4	1.27	0.021	ND	ND	0	33.36	0.556	6.580	ND	ND	6.58
5	1.17	0.020	ND	ND	0	28.60	0.477	8.449	1.572	ND	10.021
6	0.54	0.009	ND	ND	0	28.02	0.467	22.723	0.347	ND	23.07
Tomatoes											
Plot	PPt(in)	2.59									
1	1.44	0.024	0.09	ND	0.09	109.91	1.832	11.049	ND	ND	11.049
2	2.30	0.038	0.06	0.516	0.576	32.52	0.542	4.290	ND	ND	4.29
3	1.41	0.024	0.24	0.666	0.906	28.77	0.480	8.826	ND	ND	8.826
4	1.30	0.022	ND	ND	0	27.17	0.453	7.145	2.834	ND	9.979
5	1.96	0.033	ND	ND	0	28.68	0.478	5.043	2.929	ND	7.972
6	2.17	0.036	ND	ND	0	32.46	0.541	0.616	ND	ND	0.616

Tobacco	Total Soil	Total RO	Total P	Total PO4	Total Soil	Total RO	Total N	Total NO2	Total NO3	Total NO2 + NO3
Plot	TKP (mg)	P (mg)	mg	mg	TKN (mg)	N (mg)	mg	mg	mg	mg
1	38.78	0.00	38.78	0.00	4010.21	3589.48	7599.70	0.00	0.00	0.00
2	49.82	0.00	49.82	0.00	2244.18	12851.81	15096.00	3727.96	0.00	3727.96
3	376.30	7681.60	8057.90	7322.64	10470.56	93890.19	104360.74	0.00	24636.15	24636.15
4	10399.34	0.00	10399.34	0.00	273167.04	5597.61	278764.64	0.00	0.00	0.00
5	16684.33	0.00	16684.33	0.00	407839.12	61692.83	469531.95	9677.79	0.00	9677.79
6	9899.72	0.00	9899.72	0.00	513685.51	32106.04	545791.55	482.91	0.00	482.91
Tomatoes										
Plot										
1	26.17	36.75	62.92	0.00	1997.60	4511.10	6508.70	0.00	0.00	0.00
2	49.34	733.07	782.41	656.70	697.67	5459.81	6157.48	0.00	0.00	0.00
3	23.46	377.41	400.87	277.43	478.68	3676.62	4155.30	0.00	0.00	0.00
4	166.47	0.00	166.47	0.00	3479.14	4550.86	8030.00	1292.43	0.00	1292.43
5	137.18	0.00	137.18	0.00	2007.36	1668.70	3676.06	613.10	0.00	613.10
6	173.17	0.00	173.17	0.00	2590.38	254.91	2845.30	0.00	0.00	0.00

* Note plots 1-3 are no-till and plots 4-6 are conventional till.

* Note ND indicates none detected.

* Note that a missing value indicates that there was not enough sample for analysis.

Plant Science Farm August 15, 1997

	PPt (in)	0.24									
Tobacco	Soil TKP	Soil TKP	RO TKP	RO PO4	RO P Total	Soil TKN	Soil TKN	RO TKN	NO2	NO3	RO 'N Total
Plot	mg P/L	% P	mg P/L	mg P/L	mg P/L	mg N/L	% N	mg N/L	mg N/L	mg N/L	mg N/L
BTB1			0.64	0.550	1.19			0.701	1.615	ND	2.316
BTB2			0.5	0.901	1.401			0.802	3.705	ND	4.507
BTB3			0.68	0.922	1.602			0.527	3.954	ND	4.481
BTB4	1.88	0.031	0.47	0.278	0.748	24.46	0.408	0.286	ND	0.630	0.916
BTB5			1.48	1.304	2.784			0.668	0.875	1.274	2.817
BTB6	1.12	0.019	0.31	ND	0.31	32.25	0.538	0.152	ND	6.704	6.856
Tomatoes											
Plot	PPt(in)	0.24									
BTM1			1.94	5.008	6.948			7.785	ND	ND	7.785
BTM2			1.16	2.596	3.756			5.626	13.777	0.047	19.45
BTM3			0.73	1.574	2.304			1.791	ND	ND	1.791
BTM4			0.35	0.449	0.799			3.820	10.340	0.638	14.798
BTM5			0.38	0.773	1.153			0.535	8.206	0.056	8.797
BTM6			0.92	1.760	2.68			1.356	8.915	0.058	10.329

Tobacco	Total Soil	Total RO	Total P	Total PO4	Total Soil	Total RO	Total N	Total NO2	Total NO3	Total NO2 + NO3
Plot	TKP (mg)	P (mg)	mg	mg	TKN (mg)	N (mg)	mg	mg	mg	mg
BTB1	0.00	19.70	19.70	9.10	0.00	38.34	38.34	26.73	0.00	26.73
BTB2	0.00	19.73	19.73	12.69	0.00	63.47	63.47	52.18	0.00	52.18
BTB3	0.00	15.11	15.11	8.69	0.00	42.25	42.25	37.28	0.00	37.28
BTB4	1.94	13.94	15.88	5.18	25.30	17.07	42.37	0.00	11.74	11.74
BTB5	0.00	34.49	34.49	16.15	0.00	34.90	34.90	10.84	15.78	26.62
BTB6	2.26	2.51	4.77	0.00	64.99	55.51	120.50	0.00	54.28	54.28
Tomatoes										
Plot										
BTM1	0.00	51.88	51.88	37.39	0.00	58.13	58.13	0.00	0.00	0.00
BTM2	0.00	13.12	13.12	9.07	0.00	67.94	67.94	48.12	0.16	48.29
BTM3	0.00	19.32	19.32	13.20	0.00	15.02	15.02	0.00	0.00	0.00
BTM4	0.00	8.28	8.28	4.65	0.00	153.41	153.41	107.19	6.61	113.81
BTM5	0.00	7.36	7.36	4.94	0.00	56.18	56.18	52.41	0.36	52.77
BTM6	0.00	11.72	11.72	7.70	0.00	45.18	45.18	38.99	0.25	39.25

* Note plots 1-3 are no-till and plots 4-6 are conventional till.

* Note ND indicates none detected.

* Note that a missing value indicates that there was not enough sample for analysis.

Plant Science Farm August 22, 1997

	PPt (in)	0.76									
Tobacco	Soil TKP	Soil TKP	RO TKP	RO PO4	RO P Total	Soil TKN	Soil TKN	RO TKN	NO2	NO3	RO 'N Total
Plot	mg P/L	% P	mg P/L	mg P/L	mg P/L	mg N/L	% N	mg N/L	mg N/L	mg N/L	mg N/L
BTB1	0.86	0.014	0.03	ND	0.03	62.30	1.038	ND	ND	0.636	0.636
BTB2			0.07	ND	0.07			0.17	ND	0.084	0.257
BTB3	2.03	0.034	0.04	ND	0.04	40.37	0.673	0.02	ND	0.512	0.529
BTB4	1.91	0.032	ND	ND		97.07	1.618	ND	ND	0.762	0.762
BTB5	1.55	0.026	0.01	ND	0.01	93.89	1.565	ND	ND	1.125	1.125
BTB6	1.23	0.021	0.01	ND	0.01	29.68	0.495	0.07	ND	3.122	3.189
Tomatoes											
Plot	PPt(in)	0.79									
BTM1	1.21	0.020	0.20	0.408	0.608	41.79	0.697	0.54	ND	1.413	1.954
BTM2			0.17	0.332	0.502			0.72	ND	1.176	1.891
BTM3			0.19	0.346	0.536			ND	ND	1.177	1.177
BTM4	1.1	0.018	0.08	ND	0.08	163.75	2.729	2.2	ND	2.741	4.941
BTM5	1.21	0.020	0.01	ND	0.01	29.36	0.489	0.081	ND	0.458	0.539
BTM6	na	na	na	na	na	na	na	na	na	na	na

Tobacco	Total soil	Total RO	Total P	Total PO4	Total Soil	Total RO	Total N	Total NO2	Total NO3	Total NO2 + NO3
Plot	TKP (mg)	P (mg)	mg	mg	TKN (mg)	N (mg)	mg	mg	mg	mg
BTB1	7.25	26.82	34.07	0.00	525.53	568.51	1094.04	0.00	568.51	568.51
BTB2	0.00	4.61	4.61	0.00	0.00	16.92	16.92	0.00	5.53	5.53
BTB3	3.34	3.15	6.49	0.00	66.46	41.61	108.07	0.00	40.28	40.28
BTB4	21.65	0.00	21.65	0.00	1100.51	54.95	1155.45	0.00	54.95	54.95
BTB5	88.93	1.79	90.72	0.00	5386.70	201.58	5588.27	0.00	201.58	201.58
BTB6	173.15	2.59	175.73	0.00	4178.00	824.65	5002.65	0.00	807.32	807.32
Tomatoes										
Plot										
BTM1	1.89	11.25	13.14	7.55	65.15	36.16	101.31	0.00	26.15	26.15
BTM2	0.00	13.46	13.46	8.90	0.00	50.71	50.71	0.00	31.54	31.54
BTM3	0.00	8.81	8.81	5.68	0.00	19.34	19.34	0.00	19.34	19.34
BTM4	7.33	3.92	11.25	0.00	1091.40	241.86	1333.27	0.00	134.17	134.17
BTM5	7.90	0.18	8.08	0.00	191.67	9.87	201.55	0.00	8.39	8.39
BTM6	na	na	na	na	na	na	na	na	na	na

* Note plots 1-3 are no-till and plots 4-6 are conventional till.

* Note ND indicates none detected.

* Note that na indicates data that was not available.

* Note that a missing value indicates that there was not enough sample for analysis.

Plant Science Farm September 16, 1997

	PPt (in)	0.49									
Tobacco	Soil TKP	Soil TKP	RO TKP	RO PO4	RO P Total	Soil TKN	Soil TKN	RO TKN	NO2	NO3	RO 'N Total
Plot	mg P/L	% P	mg P/L	mg P/L	mg P/L	mg N/L	% N	mg N/L	mg N/L	mg N/L	mg N/L
1			ND	ND	0			0.65	1.254	0.339	2.243
2			ND	0.288	0.288			0.81	1.153	0.667	2.63
3			ND	0.278	0.278			0.47	1.645	ND	2.115
4	1.85	0.031	ND	ND	0	151.15	2.519	0.09	ND	1.449	1.539
5	1.82	0.030	ND	ND	0	25.24	0.421	0.02	ND	1.475	1.495
6	1.29	0.022	ND	ND	0	27.09	0.452	0.04	3.655	0.139	3.834
Tomatoes											
Plot	PPt(in)	0.51									
1	2.24	0.037	ND	ND	0	32.02	0.534	0.98	ND	ND	0.98
2			ND	0.295	0.295			1.16	ND	ND	1.16
3			ND	0.522	0.522			0.66	4.098	ND	4.758
4	2.48	0.041	ND	ND	0	194.74	3.246	1.03	ND	ND	1.03
5	2.83	0.047	ND	0.392	0.392	22.84	0.381	0.22	ND	ND	0.22
6	na	na	na	na	na	na	na	na	na	na	na

Tobacco	Total Soil	Total RO	Total P	Total PO4	Total Soil	Total RO	Total N	Total NO2	Total NO3	Total NO2 + NO3
Plot	TKP (mg)	P (mg)	mg	mg	TKN (mg)	N (mg)	mg	mg	mg	mg
1	0.00	0.00	0.00	0.00	0.00	119.90	119.90	67.03	18.12	85.15
2	0.00	15.13	15.13	15.13	0.00	138.21	138.21	60.59	35.05	95.64
3	0.00	10.35	10.35	10.35	0.00	78.77	78.77	61.27	0.00	61.27
4	8.41	0.00	8.41	0.00	687.46	54.87	742.32	0.00	51.66	51.66
5	29.33	0.00	29.33	0.00	406.81	139.89	546.71	0.00	138.02	138.02
6	66.52	0.00	66.52	0.00	1397.01	250.18	1647.18	238.50	9.07	247.57
Tomatoes										
Plot										
1	2.62	0.00	2.62	0.00	37.51	17.89	55.39	0.00	0.00	0.00
2	0.00	3.41	3.41	3.41	0.00	13.40	13.40	0.00	0.00	0.00
3	0.00	8.71	8.71	8.71	0.00	79.35	79.35	68.34	0.00	68.34
4	6.36	0.00	6.36	0.00	499.41	25.19	524.60	0.00	0.00	0.00
5	7.00	6.59	13.59	6.59	56.49	3.70	60.19	0.00	0.00	0.00
6	na	na	na	na	na	na	na	na	na	na

* Note plots 1-3 are no-till and plots 4-6 are conventional till.
* Note ND indicates none detected.
* Note that na indicates data that was not available.
* Note that a missing value indicates that there was not enough sample for analysis.

Plant Science Farm October 1, 1997

	PPt (in)	1.90									
Tobacco	Soil TKP	Soil TKP	RO TKP	RO PO4	RO P Total	Soil TKN	Soil TKN	RO TKN	NO2	NO3	RO 'N Total
Plot	mg P/L	% P	mg P/L	mg P/L	mg P/L	mg N/L	% N	mg N/L	mg N/L	mg N/L	mg N/L
1			ND	ND	0			ND	ND	ND	0
2			ND	ND	0			0.13	ND	ND	0.13
3	3.63	0.061	ND	0.24	0.237	520.01	8.667	ND	ND	ND	0
4	2.16	0.036	ND	ND	0	5.87	0.098	ND	ND	ND	0
5	3.06	0.051	ND	ND	0	15.84	0.264	ND	ND	ND	0
6	0.67	0.011	ND	ND	0	114.09	1.902	0.03	ND	ND	0.03
Tomatoes											
Plot	PPt(in)	1.89									
1	2.44	0.041	ND	ND	0	482.09	8.035	0.22	ND	ND	0.22
2			ND	0.43	0.428			0.37	ND	ND	0.37
3			ND	0.38	0.377			0.15	ND	ND	0.15
4	1.84	0.031	ND	ND	0	31.31	0.522	0.06	ND	ND	0.06
5	1.67	0.028	ND	ND	0	203.6	3.393	0.09	ND	ND	0.09
6	na	na	na	na	na	na	na	na	na	na	na

Tobacco	Total Soil	Total RO	Total P	Total PO4	Total Soil	Total RO	Total N	Total NO2	Total NO3	Total NO2 + NO3
Plot	TKP (mg)	P (mg)	mg	mg	TKN (mg)	N (mg)	mg	mg	mg	mg
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	58.08	58.08	0.00	0.00	0.00
3	1.87	51.41	53.28	51.41	268.44	0.00	268.44	0.00	0.00	0.00
4	11.50	0.00	11.50	0.00	31.26	0.00	31.26	0.00	0.00	0.00
5	62.51	0.00	62.51	0.00	323.60	0.00	323.60	0.00	0.00	0.00
6	62.54	0.00	62.54	0.00	10649.63	8.19	10657.82	0.00	0.00	0.00
Tomatoes										
Plot										
1	1.38	0.00	1.38	0.00	271.85	4.04	275.89	0.00	0.00	0.00
2	0.00	52.68	52.68	52.68	0.00	45.55	45.55	0.00	0.00	0.00
3	0.00	6.76	6.76	6.76	0.00	2.69	2.69	0.00	0.00	0.00
4	3.91	0.00	3.91	0.00	66.45	1.85	68.31	0.00	0.00	0.00
5	2.81	0.00	2.81	0.00	342.32	1.64	343.96	0.00	0.00	0.00
6	na	na	na	na	na	na	na	na	na	na

* Note plots 1-3 are no-till and plots 4-6 are conventional till.

* Note ND indicates none detected.

* Note that na indicates data that was not available.

* Note that a missing value indicates that there was not enough sample for analysis.

Grove Farm July 9, 1997

	PPt (in)	0.25									
Tobacco Plot	Soil TKP mg P/L	Soil TKP % P	RO TKP mg P/L	RO PO4 mg P/L	RO 'P Total mg P/L	Soil TKN mg N/L	Soil TKN % N	RO TKN mg N/L	NO2 mg N/L	NO3 mg N/L	RO 'N Total mg N/L
1	1.68	0.028	0.23	0.49	0.721	37.75	0.629	3.713	ND	0.981	4.694
2	6.10	0.102	0.74	1.18	1.924	177.15	2.953	ND	ND	3.68	3.681
3	6.92	0.115	2.42	5.71	8.133	35.57	0.593	10.313	ND	3.20	13.512
4	0.99	0.017	0.01	ND	0.01	61.84	1.031	0.045	ND	2.71	2.755
5	0.82	0.014	0.02	ND	0.02	56.91	0.949	2.614	ND	2.33	4.939
6	1.15	0.019	ND	ND	0	38.67	0.645	3.019	ND	14.43	17.449

Tobacco Plot	Total Soil TKN (mg)	Total RO N (mg)	Total N mg	Total NO2 mg	Total NO3 mg	xtal NO2 + NO mg	Total Soil TKP (mg)	Total RO P (mg)	Total P mg	Total PO4 mg
1	50.64	73.90	124.54	0	15.44	15.44	2.25	11.35	13.60	7.73
2	183.63	59.09	242.72	0.00	59.09	59.09	6.32	30.89	37.21	19.01
3	97.63	221.97	319.60	0.00	52.55	52.55	18.99	133.61	152.60	93.85
4	509.48	47.33	556.81	0.00	46.55	46.55	8.16	0.17	8.33	0.00
5	687.73	87.96	775.68	0.00	41.41	41.41	9.91	0.36	10.27	0.00
6	821.31	816.83	1638.14	0.00	675.50	675.50	24.42	0.00	24.42	0.00

* Note plots 1-3 are no-till and plots 4-6 are conventional till.

* Note ND indicates none detected.

Grove Farm July 28, 1997

	PPt (in)	0.99									
Tobacco Plot	Soil TKP mg P/L	Soil TKP % P	RO TKP mg P/L	RO PO4 mg P/L	RO 'P Total mg P/L	Soil TKN mg N/L	Soil TKN % N	RO TKN mg N/L	NO2 mg N/L	NO3 mg N/L	RO 'N Total mg N/L
1	1.86	0.031	0.08	0.514	0.594	197.8	3.297	3.48	ND	8.615	12.093
2	6.21	0.104	1.21	0.448	1.658	29.49	0.492	3.25	ND	5.254	8.505
3	7.18	0.120	7.42	0.395	7.815	25.72	0.429	69.02	ND	6.138	75.158
4	1.15	0.019	ND	58.306	58.306	30.93	0.516	15.32	ND	8.266	23.582
5	1.00	0.017	ND	3.726	3.726	31.3	0.522	2.73	ND	7.902	10.635
6	1.07	0.018	ND	0.656	0.656	32.18	0.536	25.56	ND	1.564	27.127

Tobacco Plot	Total Soil TKN (mg)	Total RO N (mg)	Total N mg	Total NO2 mg	Total NO3 mg	xtal NO2 + NO mg	Total Soil TKP (mg)	Total RO P (mg)	Total P mg	Total PO4 mg
1	0.00	295.37	295.37	0	210.42	210.42	0.00	14.51	14.51	12.55
2	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	0.00

* Note plots 1-3 are no-till and plots 4-6 are conventional till.

* Note ND indicates none detected.

Grove Farm August 8, 1997

	PPt (in)	0.50									
Tobacco	Soil TKP	Soil TKP	RO TKP	RO PO4	RO 'P Total	Soil TKN	Soil TKN	RO TKN	NO2	NO3	RO 'N Total
Plot	mg P/L	% P	mg P/L	mg P/L	mg P/L	mg N/L	% N	mg N/L	mg N/L	mg N/L	mg N/L
1	2.07	0.035	0.07	0.75	0.82	253.18	4.22	6.07	ND	1.41	7.48
2	5.56	0.093	0.89	3.02	3.91	295.63	4.93	13.03	ND	4.98	18.00
3	7.26	0.121	4.90	20.25	25.15	124.17	2.07	39.36	5.69	2.02	47.06
4	1.07	0.018	ND	0.57	0.57	66.2	1.10	8.14	5.20	0.05	13.39
5	0.07	0.001	0.02	0.57	0.59	27.11	0.45	8.78	5.68	ND	14.46
6	0.74	0.012	0.12	0.63	0.75	40.71	0.68	12.09	7.83	0.057	19.98

Tobacco	Total Soil	Total RO	Total N	Total NO2	Total NO3	Total NO2 + NO3	Total Soil	Total RO	Total P	Total PO4
Plot	TKN (mg)	N (mg)	mg	mg	mg	mg	TKP (mg)	P (mg)	mg	mg
1	0.00	125.22	125.22	0	23.57	23.57	0.00	13.68	13.68	12.50
2	88.20	673.97	762.17	0.00	186.39	186.39	1.66	146.41	148.06	113.09
3	288.36	1405.49	1693.85	212.81	60.38	273.20	16.86	751.12	767.98	604.79
4	3285.37	1067.97	4353.34	155.35	3.99	159.34	53.10	45.71	98.81	45.71
5	958.39	1208.17	2166.56	452.89	0.00	452.89	2.47	49.30	51.77	47.63
6	12084.35	4464.42	16548.77	654.26	12.74	667.00	219.66	167.60	387.26	140.78

* Note plots 1-3 are no-till and plots 4-6 are conventional till.

* Note ND indicates none detected.

Grove Farm August 25, 1997

	PPt (in)	1.27									
Tobacco	Soil TKP	Soil TKP	RO TKP	RO PO4	RO 'P Total	Soil TKN	Soil TKN	RO TKN	NO2	NO3	RO 'N Total
Plot	mg P/L	% P	mg P/L	mg P/L	mg P/L	mg N/L	% N	mg N/L	mg N/L	mg N/L	mg N/L
1	3.28	0.055	0.42	0.887	1.307	378.55	6.309	2.614	4.62	0.138	7.374
2	5.55	0.093	0.54	1.075	1.615	30.73	0.512	0.282	ND	1.697	1.979
3	5.93	0.099	1.95	5.535	7.485	27.82	0.464	0.699	ND	1.960	2.659
4	1.36	0.023	0.23	0.524	0.754	27.21	0.454	ND	ND	1.079	1.079
5	0.02	0.000	0.23	0.497	0.727	20.79	0.347	ND	ND	1.432	1.432
6	0.07	0.001	0.26	0.528	0.788	31.9	0.532	0.028	ND	2.522	2.55

Tobacco	Total Soil	Total RO	Total N	Total NO2	Total NO3	Total NO2 + NO3	Total Soil	Total RO	Total P	Total PO4
Plot	TKN (mg)	N (mg)	mg	mg	mg	mg	TKP (mg)	P (mg)	mg	mg
1	0.00	0.00	0.00	0	0	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	0.00

* Note plots 1-3 are no-till and plots 4-6 are conventional till.

* Note ND indicates none detected.

Grove Farm September 11, 1997

	PPt (in)	0.36									
Tobacco	Soil TKP	Soil TKP	RO TKP	RO PO4	RO 'P Total	Soil TKN	Soil TKN	RO TKN	NO2	NO3	RO 'N Total
Plot	mg P/L	% P	mg P/L	mg P/L	mg P/L	mg N/L	% N	mg N/L	mg N/L	mg N/L	mg N/L
1			1.63	3.70	5.33			8.77	ND	ND	8.77
2			2.69	6.73	9.42			15.76	ND	ND	15.76
3			2.57	5.91	8.48			12.23	ND	ND	12.23
4			2.3	7.16	9.46			13.67	ND	ND	13.67
5	1.88	0.031	1.57	3.59	5.16	417.93	6.97	7.28	ND	ND	7.28
6	2.32	0.039	1.53	2.57	4.10	513.40	8.56	11.57	ND	ND	11.57

Tobacco	Total Soil	Total RO	Total N	Total NO2	Total NO3	Total NO2 + NO3	Total Soil	Total RO	Total P	Total PO4
Plot	TKN (mg)	N (mg)	mg	mg	mg	mg	TKP (mg)	P (mg)	mg	mg
1	0.00	148.46	148.46	0	0	0.00	0.00	90.24	90.24	62.65
2	0.00	241.26	241.26	0.00	0	0.00	0.00	144.26	144.26	103.07
3	0.00	192.58	192.58	0.00	0	0.00	0.00	133.54	133.54	93.08
4	0.00	109.12	109.12	0.00	0	0.00	0.00	75.49	75.49	57.13
5	317.98	138.38	456.36	0.00	0	0.00	1.43	98.20	99.63	68.34
6	349.11	201.58	550.69	0.00	0	0.00	1.58	71.48	73.06	44.81

* Note plots 1-3 are no-till and plots 4-6 are conventional till.

* Note ND indicates none detected.

* Note missing values indicates that there was not enough sample for analysis.

Grove Farm October 2, 1997

	PPt (in)	2.87									
Tobacco	Soil TKP	Soil TKP	RO TKP	RO PO4	RO 'P Total	Soil TKN	Soil TKN	RO TKN	NO2	NO3	RO 'N Total
Plot	mg P/L	% P	mg P/L	mg P/L	mg P/L	mg N/L	% N	mg N/L	mg N/L	mg N/L	mg N/L
1			0.6	1.113	1.713			1.46	ND	ND	1.46
2	4.39	0.073	0.71	1.365	2.075	19.37	0.323	1.63	ND	ND	1.63
3	5.93	0.099	0.84	1.792	2.632	15.43	0.257	0.71	ND	ND	0.71
4	1.93	0.032	2.36	8.42	10.78	21.12	0.352	0.49	ND	ND	0.49
5	2.21	0.037	1.19	2.494	3.684	14.11	0.235	ND	0.767	0.275	1.042
6	1.54	0.026	0.51	3.849	4.359	14.18	0.236	0.17	ND	ND	0.17

Tobacco	Total Soil	Total RO	Total N	Total NO2	Total NO3	Total NO2 + NO3	Total Soil	Total RO	Total P	Total PO4
Plot	TKN (mg)	N (mg)	mg	mg	mg	mg	TKP (mg)	P (mg)	mg	mg
1	0.00	0.00	0.00	0	0	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	0.00

* Note plots 1-3 are no-till and plots 4-6 are conventional till.

* Note ND indicates none detected.

* Note missing values indicates that there was not enough sample for analysis.

Appendix E.

Data Summary

Appendix E

Nomenclature

RO	runoff
Yr.	year

Cocke County / Grove Farm Tobacco

Runoff (Liters)

Date	Precip. in.	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
8-14-96	2.06	421.82	.*	458.03	.*	1178.55	443.50
9-05-96	1.5	402.29	.*	2713.69	.*	1993.89	1861.14
9-25-96	1.33	42.37	.*	139.40	.*	396.73	138.00
9-30-96	1.21	80.62	.*	66.80	.*	33.29	63.96
11-07-96	1.9	18.89	.*	110.37	.*	421.64	241.89
Yr. Total	8	965.99		3468.29	.*	4024.10	2748.49
		Avg	2227.14		Avg	3386.29	
		%RO	8.74		%RO	13.29	

Runoff (Liters)

Date	Precip. in.	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
7-09-97	0.25	15.74	16.05	16.43	17.18	17.81	46.81
7-28-97	0.99	85.82	107.79	39.94	404.79	411.72	394.86
8-08-97	0.5	16.74	37.43	29.86	79.78	83.56	223.47
8-25-97	1.27	15.93	18.38	71.98	121.77	236.24	403.10
9-11-97	0.36	16.93	15.31	15.74	7.98	19.02	17.43
10-02-97	2.87	16.30	171.72	50.30	39.99	189.55	409.46
Yr. Total	6.24	167.46	366.69	224.25	671.48	957.89	1495.14
		Avg	252.80		Avg	1041.50	
		%RO	1.27		%RO	5.24	

Knox County / Plant Scienc Farm Tomato

Runoff (Liters)

Date	Precip. in.	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
7-29-96	2.22	18.82	125.61	18.82	49.02	18.82	16.61
8-01-96	2.38	18.61	185.50	18.72	57.72	18.41	16.42
8-13-96	1.15	26.66	20.86	18.82	26.56	22.46	16.32
8-26-96	0.54	18.25	18.25	18.51	18.25	17.75	16.30
9-06-96	0.86	60.15	16.61	18.51	17.87	18.19	16.37
9-18-96	1.11	18.13	32.27	18.32	18.19	17.75	28.74
10-07-96	1.68	18.25	33.29	18.38	18.25	17.87	56.00
10-25-96	0.71	18.38	18.38	18.51	18.32	18.19	16.30
11-04-96	0.7	17.94	15.19	15.31	17.68	17.62	15.37
Yr. Total	11.35	215.18	465.96	163.87	241.87	167.05	198.42
		Avg	281.67		Avg	202.45	
		%RO	0.78			0.56	

Runoff (Liters)

Date	Precip. in.	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
7-03-97	2.18	182.41	136.24	191.57	156.53	453.00	367.80
7-08-97	0.68	44.02	33.13	50.38	116.41	47.32	17.91
7-15-97	0.65	17.18	24.86	52.86	63.33	43.59	45.44
7-25-97	2.59	408.28	1272.68	416.57	456.04	209.32	413.82
8-15-97	0.24	7.47	3.49	8.39	10.37	6.39	4.37
8-22-97	0.79	18.51	26.82	16.43	48.95	18.32	
9-16-97	0.51	18.25	11.55	16.68	24.46	16.80	
10-01-97	1.89	18.38	123.10	17.94	30.87	18.25	
Yr. Total	9.53	714.49	1631.87	770.81	906.96	812.99	849.34
		Avg	1039.06		Avg	856.43	
		%RO	3.42		%RO	2.82	

Knox County / Plant Scienc Farm Tobacco

Runoff (Liters)

Date	Precip. in.	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
7-16-96	1.47	192.75	386.24	452.56	265.49	415.79	364.33
7-29-96	2.22	306.55	200.93	107.12	426.45	532.16	610.27
8-01-96	2.79	443.89	336.60	435.35	5198.13	448.22	431.10
8-13-96	1.12	112.84	17.93	35.14	293.32	185.80	267.75
8-26-96	0.58	17.62	17.84	59.57	31.17	77.42	89.67
9-06-96	0.86	112.71	17.67	17.73	38.00	126.38	93.85
9-18-96	1.14	78.72	17.84	111.02	74.82	28.69	45.97
10-07-96	1.7	181.66	166.53	243.89	86.85	59.86	78.38
10-25-96	0.71	67.99	17.84	51.67	17.17	38.17	54.78
11-04-96	0.72	331.42	17.34	17.22	17.22	25.64	65.79
Yr. Total	13.31	1846.15	1196.77	1531.28	6448.62	1938.12	2101.88
		Avg	1524.73		Avg	3496.21	
		%RO	3.60		%RO	8.24	

Runoff (Liters)

Date	Precip. in.	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
7-03-97	2.18	1657.24	759.39	9664.49	608.41	8023.55	1840.97
7-08-97	0.67	36.17	99.77	95.47	430.85	1013.31	846.60
7-15-97	0.58	50.38	83.98	63.33	81.50	712.81	250.99
7-25-97	2.5	913.82	2215.07	11965.11	850.70	6156.35	1391.68
8-15-97	0.24	16.55	14.08	9.43	18.63	12.39	8.10
8-22-97	0.76	893.88	65.82	78.67	72.11	179.18	258.59
9-16-97	0.49	53.46	52.55	37.24	35.65	93.57	65.25
10-01-97	1.9	204.63	446.80	216.92	182.41	170.37	273.03
Yr. Total	9.32	3826.14	3737.46	22130.65	2280.26	16361.53	4935.21
		Avg	9898.08		Avg	7859.00	
		%RO	33.33			26.47	

* Note that plots 1-3 are no-till and plots 4-6 are conventional till.

Cooke County / Grove Farm Tomato & Tobacco

				Sediment kg/ha Tomato			
Date	Precip. in.	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
8-14-96	2.06	0.95		45.18		941.93	973.05
9-05-96	1.5	224.50		1693.60		2156.13	2232.64
9-25-96	1.33	0.75		2.45		185.97	191.06
9-30-96	1.21	0.02		0.10		12.60	26.08
11-07-96	1.9	0.36		1.32		55.86	116.30
Yr. Total	8	226.58		1742.65		3352.49	3539.13
		Avg kg/ha	984.62		Avg kg/ha	3445.81	
		Avg lb/A	878.45		Avg lb/A	3074.28	

				Sediment kg/ha Tobacco			
Date	Precip. in.	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
7-09-97	0.25	0.51	0.40	1.05	3.16	4.64	8.15
7-28-97	0.99	1.02	2.22	3.70	115.69	111.98	358.42
8-08-97	0.5	0.00	0.11	0.89	19.05	13.57	113.92
8-25-97	1.27	0.27	0.27	1.05	13.87	29.83	106.78
9-11-97	0.36	0.09	0.07	0.10	0.16	0.29	0.26
10-02-97	2.87	0.08	0.36	1.51	6.53	25.99	59.96
Yr. Total	6.24	1.98	3.43	8.30	158.47	186.29	647.50
		Avg kg/ha	4.57		Avg kg/ha	330.75	
		Avg lb/A	4.08		Avg lb/A	295.09	

Knox County / Plant Soleno Farm Tomato

			Sediment kg/ha				
Date	Precip. in.	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
7-29-96	2.22	0.00	0.08	0.00	2.17	0.72	0.00
8-01-96	2.38	0.03	0.00	0.00	17.87	1.11	0.40
8-13-96	1.15	0.02	0.00	0.00	0.04	0.14	0.01
8-26-96	0.54	0.00	0.00	0.00	0.15	0.09	0.00
9-06-96	0.86	0.00	0.02	0.01	0.39	0.10	0.01
9-18-96	1.11	0.05	0.15	0.04	0.38	0.37	0.05
10-07-96	1.68	0.13	0.13	0.03	0.12	0.12	0.14
10-25-96	0.71	0.08	0.10	0.09	0.09	0.15	0.09
11-04-96	0.7	0.01	0.03	0.03	0.04	0.02	0.02
Yr. Total	11.35	0.32	0.51	0.20	21.26	2.82	0.71
		Avg kg/ha	0.34		Avg kg/ha	8.26	
		Avg lb/A	0.31		Avg lb/A	7.37	

			Sediment kg/ha				
Date	Precip. in.	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
7-03-97	2.18	9.11	1.59	1.63	43.17	140.47	33.07
7-08-97	0.68	2.56	0.19	0.14	26.14	17.91	2.37
7-15-97	0.65	0.82	0.19	0.28	5.58	3.52	0.60
7-25-97	2.59	6.98	8.23	6.39	49.14	26.86	30.63
8-15-97	0.24	0.08	0.01	0.01	0.06	0.05	0.03
8-22-97	0.79	0.60	0.09	0.08	2.56	2.51	
9-16-97	0.51	0.45	0.05	0.02	0.98	0.95	
10-01-97	1.89	0.22	0.37	0.04	0.81	0.65	
Yr. Total	9.53	20.81	10.73	8.59	128.44	192.90	66.69
		Avg kg/ha	13.37		Avg kg/ha	129.35	
		Avg lb/A	11.93		Avg lb/A	115.40	

Knox County / Plant Soleno Farm Tobacco

			Sediment kg/ha				
Date	Precip. in.	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
7-16-96	1.47	2.03	5.49	7.61	48.30	186.50	82.60
7-29-96	2.22	0.14	0.12	0.42	6.43	40.09	10.99
8-01-96	2.79	4.69	2.39	2.67	91.12	117.87	8.82
8-13-96	1.12	0.46	0.00	0.00	0.99	0.66	2.94
8-26-96	0.58	0.00	0.00	0.15	0.61	1.39	0.78
9-06-96	0.86	0.02	0.06	0.06	0.33	4.12	1.77
9-18-96	1.14	0.04	0.05	0.21	1.30	1.22	7.06
10-07-96	1.7	0.44	0.69	0.33	0.42	0.45	0.39
10-25-96	0.71	1.09	0.12	0.43	0.11	0.97	0.61
11-04-96	0.72	0.04	0.03	0.04	0.08	0.06	0.23
Yr. Total	13.31	8.94	8.95	11.93	149.69	353.33	116.19
		Avg kg/ha	9.94		Avg kg/ha	206.41	
		Avg lb/A	8.87		Avg lb/A	184.15	

			Sediment kg/ha				
Date	Precip. in.	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
7-03-97	2.18	15.12	11.99	116.48	365.43	1608.89	1063.06
7-08-97	0.67	0.65	0.73	1.68	5282.03	3800.89	2913.76
7-15-97	0.58	0.40	0.23	0.42	21.64	183.71	137.37
7-25-97	2.5	12.61	28.54	148.89	3142.64	5472.87	7035.92
8-15-97	0.24	0.05	0.04	0.02	0.40	0.09	0.77
8-22-97	0.76	3.24	0.16	0.63	4.35	22.02	54.03
9-16-97	0.49	0.10	0.10	0.13	1.75	6.19	19.79
10-01-97	1.9	0.34	0.03	0.20	2.04	7.84	35.82
Yr. Total	9.32	32.50	41.81	268.46	8820.27	11102.50	11260.54
		Avg kg/ha	114.26		Avg kg/ha	10394.44	
		Avg lb/A	101.94		Avg lb/A	9273.70	

* Note that plots 1-3 are no-till and plots 4-6 are conventional till.

Cocke County / Grove Farm Tobacco

Total N (mg)

Date	Precip. in.	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
7-09-97	0.25	124.54	242.72	319.60	556.81	775.68	1638.14
7-28-97	0.99	1565.30	1087.54	3249.67	18869.17	13510.84	40764.19
8-08-97	0.5	125.22	762.17	1693.85	4353.34	2166.56	16548.77
8-25-97	1.27	383.51	58.22	267.41	1115.05	1954.16	9903.58
9-11-97	0.36	148.46	241.26	192.58	109.12	456.36	550.69
10-02-97	2.87	23.80	297.94	96.45	379.09	1153.02	2285.04
Yr. Total	6.24	2370.82	2689.86	5819.56	25382.58	20016.62	71690.41
		Avg mg	3626.75		Avg mg	39029.87	
		mg/ha	289170.38		mg/ha	3111958.12	
		lb/A	0.26		lb/A	2.78	

Knox County / Plant Scienc Farm Tomato

Total N (mg)

Date	Precip. in.	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
7-03-97	2.18	3443.55	1526.78	976.08	15137.30	15384.09	3570.67
7-08-97	0.68	1001.82	173.80	187.85	5447.72	6870.26	284.39
7-15-97	0.65	357.07	208.51	266.54	3826.58	410.76	208.71
7-25-97	2.59	6508.70	6157.48	4155.30	8030.00	3676.06	2845.30
8-15-97	0.24	58.13	67.94	15.02	153.41	56.18	45.18
8-22-97	0.79	101.31	50.71	19.34	1333.27	201.55	0.00
9-16-97	0.51	119.90	138.21	78.77	742.32	546.71	1647.18
10-01-97	1.89	275.89	45.55	2.69	68.31	343.96	0.00
Yr. Total	9.53	11866.38	8368.97	5701.59	34738.90	27489.57	8601.43
		Avg	8645.64		Avg	23609.97	
		mg/ha	689340.90		mg/ha	1882487.20	
		lb/A	0.62		lb/A	1.68	

Knox County / Plant Scienc Farm Tobacco

Total N (mg)

Date	Precip. in.	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
7-03-97	2.18	12911.83	6159.23	69683.93	37088.52	468757.26	207306.49
7-08-97	0.67	685.38	944.18	1542.68	1246464.99	780671.94	494602.60
7-15-97	0.58	267.09	330.13	311.75	6002.35	46569.09	24206.00
7-25-97	2.5	7599.70	15096.00	104360.74	278764.64	469531.95	545791.55
8-15-97	0.24	38.34	63.47	42.25	42.37	34.90	120.50
8-22-97	0.76	1094.04	16.92	108.07	1155.45	5588.27	5002.65
9-16-97	0.49	119.90	138.21	78.77	742.32	546.71	1647.18
10-01-97	1.9	0.00	56.71	239.49	27.89	288.71	9509.65
Yr. Total	9.32	22716.28	22804.84	176367.69	1570288.54	1771988.81	1288186.62
		Avg	73962.93		Avg	1543487.99	
		mg/ha	5897267.13		mg/ha	123066520.38	
		lb/A	5.26		lb/A	109.80	

* Note that plots 1-3 are no-till and plots 4-6 are conventional till.

Cocke County / Grove Farm Tobacco

Total NO2 + NO3 (mg)

Date	Precip. in.	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
7-09-97	0.25	15.44	59.09	52.55	46.55	41.41	675.50
7-28-97	0.99	739.31	566.34	245.16	3345.97	3253.40	617.57
8-08-97	0.5	23.57	186.39	273.20	159.34	452.89	667.00
8-25-97	1.27	75.83	31.19	141.08	131.39	338.29	1016.63
9-11-97	0.36	0.00	0.00	0.00	0.00	0.00	0.00
10-02-97	2.87	0.00	0.00	0.00	0.00	82.80	0.00
Yr. Total	6.24	854.15	843.01	711.99	3683.25	4168.78	2976.70
		Avg mg	803.05		Avg mg	3609.58	
		mg/ha	64029.36		mg/ha	287801.42	
		lb/A	0.06		lb/A	0.26	

Knox County / Plant Scienc Farm Tomato

Total NO2 + NO3 (mg)

Date	Precip. in.	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
7-03-97	2.18	263.95	1119.87	329.51	148.39	433.52	228.40
7-08-97	0.68	56.43	48.77	39.50	131.19	68.01	21.42
7-15-97	0.65	15.53	24.96	31.35	64.41	53.66	56.21
7-25-97	2.59	0.00	0.00	0.00	1292.43	613.10	0.00
8-15-97	0.24	0.00	48.29	0.00	113.81	52.77	39.25
8-22-97	0.79	26.15	31.54	19.34	134.17	8.39	0.00
9-16-97	0.51	0.00	68.34	0.00	0.00	0.00	0.00
10-01-97	1.89	0.00	0.00	0.00	0.00	0.00	0.00
Yr. Total	9.53	362.05	1341.77	419.69	1884.40	1229.44	345.27
		Avg	707.84		Avg	1153.04	
		mg/ha	56437.85		mg/ha	91934.90	
		lb/A	0.0504		lb/A	0.0820	

Knox County / Plant Scienc Farm Tobacco

Total NO2 + NO3 (mg)

Date	Precip. in.	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
7-03-97	2.18	6211.35	3111.99	**********	4150.56	83204.20	**********
7-08-97	0.67	207.20	542.44	577.29	535.55	1380.13	1466.31
7-15-97	0.58	36.68	62.48	64.41	98.94	893.15	300.44
7-25-97	2.5	0.00	3727.96	**********	0.00	9677.79	482.91
8-15-97	0.24	26.73	52.18	37.28	11.74	26.62	54.28
8-22-97	0.76	568.51	5.53	40.28	54.95	201.58	807.32
9-16-97	0.49	85.15	95.64	61.27	51.66	138.02	247.57
10-01-97	1.9	0.00	0.00	0.00	0.00	0.00	0.00
Yr. Total	9.32	7135.62	7598.22	**********	4903.40	95521.49	**********
		Avg	21131.20		Avg	38580.27	
		mg/ha	1684848.43		mg/ha	3076110.18	
		lb/A	1.5032		lb/A	2.7444	

* Note that plots 1-3 are no-till and plots 4-6 are conventional till.

Cocke County / Grove Farm Tobacco

			Total P (mg)				
Date	Precip. in.	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
7-09-97	0.25	13.60	37.21	152.60	8.33	10.27	24.42
7-28-97	0.99	55.94	214.68	381.32	23948.14	1825.83	1258.30
8-08-97	0.5	13.68	148.06	767.98	98.81	51.77	387.26
8-25-97	1.27	23.13	33.63	554.98	140.98	173.30	337.12
9-11-97	0.36	90.24	144.26	133.54	75.49	99.63	73.06
10-02-97	2.87	27.93	360.41	155.73	463.92	847.96	2025.44
Yr. Total	6.24	224.51	938.25	2146.14	24735.67	3008.75	4105.60
		Avg mg	1102.97		Avg mg	10616.67	
		mg/ha	87942.58		mg/ha	846496.45	
		lb/A	0.08		lb/A	0.76	

Knox County / Plant & Soil Scienc Farm Tomato

			Total P (mg)				
Date	Precip. in.	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
7-03-97	2.18	47.97	113.58	73.75	219.33	717.37	204.19
7-08-97	0.68	12.58	1.36	0.32	65.38	103.21	14.77
7-15-97	0.65	4.37	1.24	1.90	32.71	19.35	3.69
7-25-97	2.59	62.92	782.41	400.87	166.47	137.18	173.17
8-15-97	0.24	51.88	13.12	19.32	8.28	7.36	11.72
8-22-97	0.79	13.14	13.46	8.81	11.25	8.08	0.00
9-16-97	0.51	2.62	3.41	8.71	6.36	13.59	0.00
10-01-97	1.89	1.38	52.68	6.76	3.91	2.81	0.00
Yr. Total	9.53	196.86	981.28	520.43	513.68	1008.95	407.54
		Avg	566.19		Avg	643.39	
		mg/ha	45143.72		mg/ha	51299.50	
		lb/A	0.04		lb/A	0.05	

Knox County / Plant & Soil Scienc Farm Tobacco

			Total P (mg)				
Date	Precip. in.	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
7-03-97	2.18	1115.23	271.79	12816.78	1523.45	4862.87	2548.33
7-08-97	0.67	22.60	4.87	117.33	14863.90	10398.80	5997.77
7-15-97	0.58	3.24	1.14	2.04	62.58	512.19	307.82
7-25-97	2.5	38.78	49.82	8057.90	10399.34	16684.33	9899.72
8-15-97	0.24	19.70	19.73	15.11	15.88	34.49	4.77
8-22-97	0.76	34.07	4.61	6.49	21.65	90.72	175.73
9-16-97	0.49	0.00	15.13	10.35	8.41	29.33	66.52
10-01-97	1.9	0.00	0.00	53.28	11.50	62.51	62.54
Yr. Total	9.32	1233.62	367.09	21079.29	26906.73	32675.24	19063.20
		Avg	7560.00		Avg	26215.06	
		mg/ha	602779.37		mg/ha	2090198.14	
		lb/A	0.54		lb/A	1.86	

* Note that plots 1-3 are no-till and plots 4-6 are conventional till.

Cocke County / Grove Farm Tobacco

Date	Precip. in.	Plot 1	Total PO4 (mg) Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
7-09-97	0.25	7.73	19.01	93.85	0.00	0.00	0.00
7-28-97	0.99	44.11	48.29	15.78	23601.48	1534.06	259.03
8-08-97	0.5	12.50	113.09	604.79	45.71	47.63	140.78
8-25-97	1.27	14.13	19.76	398.41	63.81	117.41	212.84
9-11-97	0.36	62.65	103.07	93.08	57.13	68.34	44.81
10-02-97	2.87	18.15	234.40	90.13	336.70	472.74	1576.01
Yr. Total	6.24	159.27	537.62	1296.04	24104.83	2240.18	2233.48
		Avg mg	664.31		Avg mg	9526.16	
		mg/ha	52967.19		mg/ha	759546.93	
		lb/A	0.05		lb/A	0.68	

Knox County / Plant Scienc Farm Tomato

Date	Precip. in.	Plot 1	Total PO4 (mg) Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
7-03-97	2.18	0	85.8293709	60.53766	0	0	0
7-08-97	0.68	0	0	0	0	0	0
7-15-97	0.65	0.00	0.00	0.00	0.00	0.00	0.00
7-25-97	2.59	0.00	656.70	277.43	0.00	0.00	0.00
8-15-97	0.24	37.39	9.07	13.20	4.65	4.94	7.70
8-22-97	0.79	7.55	8.90	5.68	0.00	0.00	0.00
9-16-97	0.51	0.00	3.41	8.71	0.00	6.59	0.00
10-01-97	1.89	0.00	52.68	6.76	0.00	0.00	0.00
Yr. Total	9.53	44.94	816.60	372.32	4.65	11.52	7.70
		Avg	411.29		Avg	7.96	
		mg/ha	32793.05		mg/ha	634.57	
		lb/A	0.0293		lb/A	0.0006	

Knox County / Plant Scienc Farm Tobacco

Date	Precip. in.	Plot 1	Total PO4 (mg) Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
7-03-97	2.18	783.8761	225.539884	10060.73	0	0	0
7-08-97	0.67	11.79	0.00	88.40	0.00	0.00	0.00
7-15-97	0.58	0.00	0.00	0.00	0.00	0.00	0.00
7-25-97	2.5	0.00	0.00	7322.64	0.00	0.00	0.00
8-15-97	0.24	9.10	12.69	8.69	5.18	16.15	0.00
8-22-97	0.76	0.00	0.00	0.00	0.00	0.00	0.00
9-16-97	0.49	0.00	15.13	10.35	0.00	0.00	0.00
10-01-97	1.9	0.00	0.00	51.41	0.00	0.00	0.00
Yr. Total	9.32	804.77	253.36	17542.24	5.18	16.15	0.00
		Avg	6200.12		Avg	7.11	
		mg/ha	494352.84		mg/ha	567.00	
		lb/A	0.4411		lb/A	0.0005	

* Note that plots 1-3 are no-till and plots 4-6 are conventional till.

Appendix F.

SAS Programs

SAS Program for Runoff Analysis

```
title 'Analysis of Total Runoff';
data one;
 informat date mmddyy8.;
 input Loc $ Year Date  Precip Plot1 Plot2 Plot3  Plot4   Plot5 Plot6;
 format date mmddyy8.;
 year=year(date);
cards;
KTM  1996  07-29-96  2.22  18.82  125.61  18.82  49.02  18.82  16.61
KTM  1996  08-01-96  2.38  18.61  185.50  18.72  57.72  18.41  16.42
KTM  1996  08-13-96  1.15  26.66  20.86  18.82  26.56  22.46  16.32
KTM  1996  08-26-96  0.54  18.25  18.25  18.51  18.25  17.75  16.30
KTM  1996  09-06-96  0.86  60.15  16.61  18.51  17.87  18.19  16.37
KTM  1996  09-18-96  1.11  18.13  32.27  18.32  18.19  17.75  28.74
KTM  1996  10-07-96  1.68  18.25  33.29  18.38  18.25  17.87  56.00
KTM  1996  10-25-96  0.71  18.38  18.38  18.51  18.32  18.19  16.30
KTM  1996  11-04-96  0.7  17.94  15.19  15.31  17.68  17.62  15.37
KTM  1997  07-03-97  2.18  182.41  136.24  191.57  156.53  453.00  367.80
KTM  1997  07-08-97  0.68  44.02  33.13  50.38  116.41  47.32  17.91
KTM  1997  07-15-97  0.65  17.18  24.86  52.86  63.33  43.59  45.44
KTM  1997  07-25-97  2.59  408.28  1272.68  416.57  456.04  209.32  413.82
KTM  1997  08-15-97  0.24  7.47  3.49  8.39  10.37  6.39  4.37
KTM  1997  08-22-97  0.79  18.51  26.82  16.43  48.95  18.32
KTM  1997  09-16-97  0.51  18.25  11.55  16.68  24.46  16.80
KTM  1997  10-01-97  1.89  18.38  123.10  17.94  30.87  18.25
KTB  1996  07-16-96  1.47  188.08  391.46  465.15  262.51  424.02  367.56
KTB  1996  07-29-96  2.22  305.63  196.30  103.08  423.68  512.65  609.77
KTB  1996  08-01-96  2.79  455.39  337.64  445.82  5092.03  460.26  441.08
KTB  1996  08-13-96  1.12  108.90  18.41  34.53  291.63  181.03  264.87
KTB  1996  08-26-96  0.58  18.06  18.32  57.57  30.75  74.64  86.42
KTB  1996  09-06-96  0.86  108.73  18.13  18.19  37.18  122.09  90.47
KTB  1996  09-18-96  1.14  75.88  18.32  107.03  72.17  28.46  44.66
KTB  1996  10-07-96  1.7  176.84  161.68  240.11  83.69  57.89  75.50
KTB  1996  10-25-96  0.71  65.63  18.32  50.11  17.32  37.37  52.89
KTB  1996  11-04-96  0.72  332.03  17.75  17.62  17.62  25.54  63.62
KTB  1997  07-03-97  2.18  1657.24  759.39  9664.49  608.41  8023.55  1840.97
KTB  1997  07-08-97  0.67  36.17  99.77  95.47  430.85  1013.31  846.60
KTB  1997  07-15-97  0.58  50.38  83.98  63.33  81.50  712.81  250.99
KTB  1997  07-25-97  2.5  913.82  2215.07  11965.11  850.70  6156.35  1391.68
KTB  1997  08-15-97  0.24  16.55  14.08  9.43  18.63  12.39  8.10
KTB  1997  08-22-97  0.76  893.88  65.82  78.67  72.11  179.18  258.59
KTB  1997  09-16-97  0.49  53.46  52.55  37.24  35.65  93.57  65.25
KTB  1997  10-01-97  1.9  204.63  446.80  216.92  182.41  170.37  273.03
CTM  1996  08-14-96  2.06  421.82  ."  458.03  ."  1178.55  443.50
CTM  1996  09-05-96  1.5  402.29  ."  2713.69  ."  1993.89  1861.14
CTM  1996  09-25-96  1.33  42.37  ."  139.40  ."  396.73  138.00
CTM  1996  09-30-96  1.21  80.62  ."  66.80  ."  33.29  63.96
CTM  1996  11-07-96  1.9  18.89  ."  110.37  ."  421.64  241.89
CTB  1997  07-09-97  0.25  15.74  16.05  16.43  17.18  17.81  46.81
CTB  1997  07-28-97  0.99  85.82  107.79  39.94  404.79  411.72  394.86
CTB  1997  08-08-97  0.5  16.74  37.43  29.86  79.78  83.56  223.47
CTB  1997  08-25-97  1.27  15.93  18.38  71.98  121.77  236.24  403.10
CTB  1997  09-11-97  0.36  16.93  15.31  15.74  7.98  19.02  17.43
CTB  1997  10-02-97  2.87  16.30  171.72  50.30  39.99  189.55  409.46
;
proc print; run;

data notill; set one;
 treat='notill';
 drop plot1-plot6;
 totalro=plot1; output;
 totalro=plot2; output;
 totalro=plot3; output;
run;
data till; set one;
 treat='till';
 drop plot1-plot6;
 totalro=plot4; output;
 totalro=plot5; output;
```

SAS Program for Runoff Analysis

```
 totalro=plot6; output;
run;
data final; set till notill;
  logro=log(totalro+1);
run;

*****************************************************;
********* for variables with multi year data *******;
proc mixed data=final;
title2 'analysis to get untransformed means';
 class year date loc treat;
 model totalro = year loc year*loc date(year*loc)
          treat treat*loc treat*year treat*year*loc
          treat*date(year*loc) /predicted;
 lsmeans year loc year*loc date(year*loc)
          treat treat*loc treat*year treat*year*loc
          treat*date(year*loc) / pdiff;
 make 'lsmeans' out=mmm noprint;
 make 'diffs' out=ppp noprint;
 make 'predicted' out=rrr noprint;
run;

%include 'a:pdmix612.sas';
%pdmix612(ppp,mmm);
proc univariate plot normal data=rrr;
 var _resid_;
run;
*********************************************************;



 proc mixed data=final;
title2 'analysis for transformed variable';
 class year date loc treat;
 model logro = year loc year*loc date(year*loc)
          treat treat*loc treat*year treat*year*loc
          treat*date(year*loc) /predicted;
 lsmeans year loc year*loc date(year*loc)
          treat treat*loc treat*year treat*year*loc
          treat*date(year*loc) / pdiff;
 make 'lsmeans' out=mmm noprint;
 make 'diffs' out=ppp noprint;
 make 'predicted' out=rrr noprint;
run;

%include 'a:pdmix612.sas';
%pdmix612(ppp,mmm);
proc univariate plot normal data=rrr;
 var _resid_;
run;
```

SAS Program for Sediment Loss Analysis

```
title 'Analysis of Total Sediment Loss';
data one;
 informat date mmddyy8.;
 input Loc $ Year Date  Precip Plot1 Plot2 Plot3 Plot4  Plot5 Plot6;
 format date mmddyy8.;
 year=year(date);
cards;
KTM   1996   07-29-96   2.22   0.00   0.08   0.00   2.17   0.72   0.00
KTM   1996   08-01-96   2.38   0.03   0.00   0.00   17.87   1.11   0.40
KTM   1996   08-13-96   1.15   0.02   0.00   0.00   0.04   0.14   0.01
KTM   1996   08-26-96   0.54   0.00   0.00   0.00   0.15   0.09   0.00
KTM   1996   09-06-96   0.86   0.00   0.02   0.01   0.39   0.10   0.01
KTM   1996   09-18-96   1.11   0.05   0.15   0.04   0.38   0.37   0.05
KTM   1996   10-07-96   1.68   0.13   0.13   0.03   0.12   0.12   0.14
KTM   1996   10-25-96   0.71   0.08   0.10   0.09   0.09   0.15   0.09
KTM   1996   11-04-96   0.7   0.01   0.03   0.03   0.04   0.02   0.02
KTM   1997   07-03-97   2.18   9.11   1.59   1.63   43.17   140.47   33.07
KTM   1997   07-08-97   0.68   2.56   0.19   0.14   26.14   17.91   2.37
KTM   1997   07-15-97   0.65   0.82   0.19   0.28   5.58   3.52   0.60
KTM   1997   07-25-97   2.59   6.98   8.23   6.39   49.14   26.86   30.63
KTM   1997   08-15-97   0.24   0.08   0.01   0.01   0.06   0.05   0.03
KTM   1997   08-22-97   0.79   0.60   0.09   0.08   2.56   2.51   ."
KTM   1997   09-16-97   0.51   0.45   0.05   0.02   0.98   0.95   ."
KTM   1997   10-01-97   1.89   0.22   0.37   0.04   0.81   0.65   ."
KTB   1996   07-16-96   1.47   2.03   5.49   7.61   48.30   186.50   82.60
KTB   1996   07-29-96   2.22   0.14   0.12   0.42   6.43   40.09   10.99
KTB   1996   08-01-96   2.79   4.69   2.39   2.67   91.12   117.87   8.82
KTB   1996   08-13-96   1.12   0.46   0.00   0.00   0.99   0.66   2.94
KTB   1996   08-26-96   0.58   0.00   0.00   0.15   0.61   1.39   0.78
KTB   1996   09-06-96   0.86   0.02   0.06   0.06   0.33   4.12   1.77
KTB   1996   09-18-96   1.14   0.04   0.05   0.21   1.30   1.22   7.06
KTB   1996   10-07-96   1.7   0.44   0.69   0.33   0.42   0.45   0.39
KTB   1996   10-25-96   0.71   1.09   0.12   0.43   0.11   0.97   0.61
KTB   1996   11-04-96   0.72   0.04   0.03   0.04   0.08   0.06   0.23
KTB   1997   07-03-97   2.18   15.12   11.99   116.48   365.43   1608.89   1063.06
KTB   1997   07-08-97   0.67   0.65   0.73   1.68   5282.03   3800.89   2913.76
KTB   1997   07-15-97   0.58   0.40   0.23   0.42   21.64   183.71   137.37
KTB   1997   07-25-97   2.5   12.61   28.54   148.89   3142.64   5472.87   7035.92
KTB   1997   08-15-97   0.24   0.05   0.04   0.02   0.40   0.09   0.77
KTB   1997   08-22-97   0.76   3.24   0.16   0.63   4.35   22.02   54.03
KTB   1997   09-16-97   0.49   0.10   0.10   0.13   1.75   6.19   19.79
KTB   1997   10-01-97   1.9   0.34   0.03   0.20   2.04   7.84   35.82
CTM   1996   08-14-96   2.06   0.95   ."   45.18   ."   941.93   973.05
CTM   1996   09-05-96   1.5   224.50   ."   1693.60   ."   2156.13   2232.64
CTM   1996   09-25-96   1.33   0.75   ."   2.45   ."   185.97   191.06
CTM   1996   09-30-96   1.21   0.02   ."   0.10   ."   12.60   26.08
CTM   1996   11-07-96   1.9   0.36   ."   1.32   ."   55.86   116.30
CTB   1997   07-09-97   0.25   0.51   0.40   1.05   3.16   4.64   8.15
CTB   1997   07-28-97   0.99   1.02   2.22   3.70   115.69   111.98   358.42
CTB   1997   08-08-97   0.5   0.00   0.11   0.89   19.05   13.57   113.92
CTB   1997   08-25-97   1.27   0.27   0.27   1.05   13.87   29.83   106.78
CTB   1997   09-11-97   0.36   0.09   0.07   0.10   0.16   0.29   0.26
CTB   1997   10-02-97   2.87   0.08   0.36   1.51   6.53   25.99   59.96
;
proc print; run;

data notill; set one;
 treat='notill';
 drop plot1-plot6;
 totalsed=plot1; output;
 totalsed=plot2; output;
 totalsed=plot3; output;
run;
data till; set one;
 treat='till';
 drop plot1-plot6;
 totalsed=plot4; output;
 totalsed=plot5; output;
```

```
 totalsed=plot6; output;
run;
data final; set till notill;
 logsed=log(totalsed+1);
run;

************************************************;

*************************************************;
********* for variables with multi year data *******;
proc mixed data=final;
title2 'analysis to get untransformed means';
 class year date loc treat;
 model totalsed = year loc year*loc date(year*loc)
          treat treat*loc treat*year treat*year*loc
          treat*date(year*loc) /predicted;
 lsmeans year loc year*loc date(year*loc)
          treat treat*loc treat*year treat*year*loc
          treat*date(year*loc) / pdiff;
 make 'lsmeans' out=mmm noprint;
 make 'diffs' out=ppp noprint;
 make 'predicted' out=rrr noprint;
run;

%include 'a:pdmix612.sas';
%pdmix612(ppp,mmm);
proc univariate plot normal data=rrr;
 var _resid_;
run;
*******************************************************;


 proc mixed data=final;
title2 'analysis for transformed variable';
 class year date loc treat;
 model logsed = year loc year*loc date(year*loc)
          treat treat*loc treat*year treat*year*loc
          treat*date(year*loc) /predicted;
 lsmeans year loc year*loc date(year*loc)
          treat treat*loc treat*year treat*year*loc
          treat*date(year*loc) / pdiff;
 make 'lsmeans' out=mmm noprint;
 make 'diffs' out=ppp noprint;
 make 'predicted' out=rrr noprint;
run;

%include 'a:pdmix612.sas';
%pdmix612(ppp,mmm);
proc univariate plot normal data=rrr;
 var _resid_;
run;
```

SAS Program for Total N Analysis

```
 title 'Analysis of Total N';
data one;
 informat date mmddyy8.;
 input Loc $ Year Date  Precip Plot1 Plot2 Plot3  Plot4  Plot5 Plot6;
 format date mmddyy8.;
 year=year(date);
cards;
KTM   1997   07-03-97   2.18   3443.55   1526.78   976.08   15137.30   15384.09   3570.67
KTM   1997   07-08-97   0.68   1001.82   173.80   187.85   5447.72   6870.26   284.39
KTM   1997   07-15-97   0.65   357.07   208.51   266.54   3826.58   410.76   208.71
KTM   1997   07-25-97   2.59   6508.70   6157.48   4155.30   8030.00   3676.06   2845.30
KTM   1997   08-15-97   0.24   58.13   67.94   15.02   153.41   56.18   45.18
KTM   1997   08-22-97   0.79   101.31   50.71   19.34   1333.27   201.55   0.00
KTM   1997   09-16-97   0.51   119.90   138.21   78.77   742.32   546.71   1647.18
KTM   1997   10-01-97   1.89   275.89   45.55   2.69   68.31   343.96   0.00
KTB   1997   07-03-97   2.18   12911.83   6159.23   69683.93   37088.52   468757.26   207306.49
KTB   1997   07-08-97   0.67   685.38   944.18   1542.68   1246464.99   780671.94   494602.60
KTB   1997   07-15-97   0.58   267.09   330.13   311.75   6002.35   46569.09   24206.00
KTB   1997   07-25-97   2.5   7599.70   15096.00   104360.74   278764.64   469531.95   545791.55
KTB   1997   08-15-97   0.24   38.34   63.47   42.25   42.37   34.90   120.50
KTB   1997   08-22-97   0.76   1094.04   16.92   108.07   1155.45   5588.27   5002.65
KTB   1997   09-16-97   0.49   119.90   138.21   78.77   742.32   546.71   1647.18
KTB   1997   10-01-97   1.9   0.00   56.71   239.49   27.89   288.71   9509.65
CTB   1997   07-09-97   0.25   124.54   242.72   319.60   556.81   775.68   1638.14
CTB   1997   07-28-97   0.99   1565.30   1087.54   3249.67   18869.17   13510.84   40764.19
CTB   1997   08-08-97   0.5   125.22   762.17   1693.85   4353.34   2166.56   16548.77
CTB   1997   08-25-97   1.27   383.51   58.22   267.41   1115.05   1954.16   9903.58
CTB   1997   09-11-97   0.36   148.46   241.26   192.58   109.12   456.36   550.69
CTB   1997   10-02-97   2.87   23.80   297.94   96.45   379.09   1153.02   2285.04
;
proc print; run;

data notill; set one;
 treat='notill';
 drop plot1-plot6;
 totaln=plot1; output;
 totaln=plot2; output;
 totaln=plot3; output;
run;
data till; set one;
 treat='till';
 drop plot1-plot6;
 totaln=plot4; output;
 totaln=plot5; output;
 totaln=plot6; output;
run;
data final; set till notill;
  logn=log(totaln+1);
run;

***************************************************;
proc mixed data=final;
 title2 ' analysis to get untransformed means';
 class  date loc treat;
 model totaln =  loc  date(loc)
            treat treat*loc
            treat*date(loc) /predicted;
 lsmeans loc  date(loc)
            treat treat*loc
            treat*date(loc) /pdiff;
 make 'lsmeans' out=mmm noprint;
 make 'diffs' out=ppp noprint;
 make 'predicted' out=rrr noprint;
run;
%include 'a:pdmix612.sas';
%pdmix612(ppp,mmm);
proc univariate plot normal data=rrr;
```

SAS Program for Total N Analysis

```
 var _resid_;
run;
************************************************;


************************************************;
proc mixed data=final;
 title2 'analysis for transformed variable';
 class  date loc treat;
 model logn =  loc  date(loc)
           treat treat*loc
           treat*date(loc) /predicted;
 lsmeans loc  date(loc)
           treat treat*loc
           treat*date(loc)/ pdiff;
 make 'lsmeans' out=mmm noprint;
 make 'diffs' out=ppp noprint;
 make 'predicted' out=rrr noprint;
run;

%include 'a:pdmix612.sas';
%pdmix612(ppp,mmm);
proc univariate plot normal data=rrr;
 var _resid_;
run;
****************************************************;
```

SAS Program for NO_2=NO_3 Analysis

```
title 'Analysis of Total NO2+NO3';
data one;
 informat date mmddyy8.;
 input Loc $ Year Date  Precip Plot1 Plot2 Plot3  Plot4   Plot5 Plot6;
 format date mmddyy8.;
 year=year(date);
cards;
KTM   1997   07-03-97   2.18   263.95   1119.87   329.51   148.39   433.52   228.40
KTM   1997   07-08-97   0.68   56.43   48.77   39.50   131.19   68.01   21.42
KTM   1997   07-15-97   0.65   15.53   24.96   31.35   64.41   53.66   56.21
KTM   1997   07-25-97   2.59   0.00   0.00   0.00   1292.43   613.10   0.00
KTM   1997   08-15-97   0.24   0.00   48.29   0.00   113.81   52.77   39.25
KTM   1997   08-22-97   0.79   26.15   31.54   19.34   134.17   8.39   0.00
KTM   1997   09-16-97   0.51   0.00   68.34   0.00   0.00   0.00   0.00
KTM   1997   10-01-97   1.89   0.00   0.00   0.00   0.00   0.00   0.00
KTB   1997   07-03-97   2.18   6211.35   3111.99   23243.09   4150.56   83204.20   11957.07
KTB   1997   07-08-97   0.67   207.20   542.44   577.29   535.55   1380.13   1466.31
KTB   1997   07-15-97   0.58   36.68   62.48   64.41   98.94   893.15   300.44
KTB   1997   07-25-97   2.5   0.00   3727.96   24636.15   0.00   9677.79   482.91
KTB   1997   08-15-97   0.24   26.73   52.18   37.28   11.74   26.62   54.28
KTB   1997   08-22-97   0.76   568.51   5.53   40.28   54.95   201.58   807.32
KTB   1997   09-16-97   0.49   85.15   95.64   61.27   51.66   138.02   247.57
KTB   1997   10-01-97   1.9   0.00   0.00   0.00   0.00   0.00   0.00
CTB   1997   07-09-97   0.25   15.44   59.09   52.55   46.55   41.41   675.50
CTB   1997   07-28-97   0.99   739.31   566.34   245.16   3345.97   3253.40   617.57
CTB   1997   08-08-97   0.5   23.57   186.39   273.20   159.34   452.89   667.00
CTB   1997   08-25-97   1.27   75.83   31.19   141.08   131.39   338.29   1016.63
CTB   1997   09-11-97   0.36   0.00   0.00   0.00   0.00   0.00   0.00
CTB   1997   10-02-97   2.87   0.00   0.00   0.00   0.00   82.80   0.00
;
proc print; run;

data notill; set one;
 treat='notill';
 drop plot1-plot6;
 totalno2=plot1; output;
 totalno2=plot2; output;
 totalno2=plot3; output;
run;
data till; set one;
 treat='till';
 drop plot1-plot6;
 totalno2=plot4; output;
 totalno2=plot5; output;
 totalno2=plot6; output;
run;
data final; set till notill;
  logno2=log(totalno2+1);
run;

**********************************************;
proc mixed data=final;
 title2 ' analysis to get untransformed means';
 class  date loc treat;
 model totalno2 =  loc  date(loc)
            treat treat*loc
            treat*date(loc) /predicted;
 lsmeans loc  date(loc)
            treat treat*loc
            treat*date(loc) /pdiff;
 make 'lsmeans' out=mmm noprint;
 make 'diffs' out=ppp noprint;
 make 'predicted' out=rrr noprint;
run;
%include 'a:pdmix612.sas';
%pdmix612(ppp,mmm);
proc univariate plot normal data=rrr;
 var _resid_;
```

SAS Program for NO2 + NO3 Analysis

```
run;
**************************************************;


**************************************************;
proc mixed data=final;
 title2 'analysis for transformed variable';
 class  date loc treat;
 model logno2 =  loc  date(loc)
           treat treat*loc
           treat*date(loc) /predicted;
 lsmeans loc  date(loc)
           treat treat*loc
           treat*date(loc)/ pdiff;
 make 'lsmeans' out=mmm noprint;
 make 'diffs' out=ppp noprint;
 make 'predicted' out=rrr noprint;
run;

%include 'a:pdmix612.sas';
%pdmix612(ppp,mmm);
proc univariate plot normal data=rrr;
 var _resid_;
run;
*****************************************************;
```

SAS Program for Total P Analysis

```
title 'Analysis of Total P';
data one;
 informat date mmddyy8.;
 input Loc $ Year Date  Precip Plot1 Plot2 Plot3  Plot4   Plot5 Plot6;
 format date mmddyy8.;
 year=year(date);
cards;
KTM   1997   07-03-97   2.18    47.97     113.58    73.75    219.33    717.37    204.19
KTM   1997   07-08-97   0.68    12.58     1.36    0.32    65.38     103.21    14.77
KTM   1997   07-15-97   0.65    4.37    1.24    1.90    32.71    19.35    3.69
KTM   1997   07-25-97   2.59    62.92     782.41     400.87    166.47    137.18    173.17
KTM   1997   08-15-97   0.24    51.88     13.12    19.32    8.28    7.36    11.72
KTM   1997   08-22-97   0.79    13.14     13.46    8.81    11.25    8.08    0.00
KTM   1997   09-16-97   0.51    2.62    3.41    8.71    6.36    13.59    0.00
KTM   1997   10-01-97   1.89    1.38    52.68    6.76    3.91    2.81    0.00
KTB   1997   07-03-97   2.18    1115.23    271.79    12816.78    1523.45    4862.87    2548.33
KTB   1997   07-08-97   0.67    22.60    4.87    117.33    14863.90    10398.80    5997.77
KTB   1997   07-15-97   0.58    3.24    1.14    2.04    62.58    512.19    307.82
KTB   1997   07-25-97   2.5    38.78    49.82    8057.90    10399.34    16684.33    9899.72
KTB   1997   08-15-97   0.24    19.70    19.73    15.11    15.88    34.49    4.77
KTB   1997   08-22-97   0.76    34.07    4.61    6.49    21.65    90.72    175.73
KTB   1997   09-16-97   0.49    0.00    15.13    10.35    8.41    29.33    66.52
KTB   1997   10-01-97   1.9    0.00    0.00    53.28    11.50    62.51    62.54
CTB   1997   07-09-97   0.25    13.60    37.21    152.60    8.33    10.27    24.42
CTB   1997   07-28-97   0.99    55.94    214.68    381.32    23948.14    1825.83    1258.30
CTB   1997   08-08-97   0.5    13.68    148.06    767.98    98.81    51.77    387.26
CTB   1997   08-25-97   1.27    23.13    33.63    554.98    140.98    173.30    337.12
CTB   1997   09-11-97   0.36    90.24    144.26    133.54    75.49    99.63    73.06
CTB   1997   10-02-97   2.87    27.93    360.41    155.73    463.92    847.96    2025.44
;
proc print; run;

data notill; set one;
 treat='notill';
 drop plot1-plot6;
 totalp=plot1; output;
 totalp=plot2; output;
 totalp=plot3; output;
run;
data till; set one;
 treat='till';
 drop plot1-plot6;
 totalp=plot4; output;
 totalp=plot5; output;
 totalp=plot6; output;
run;
data final; set till notill;
  logp=log(totalp+1);
run;

**************************************************;
proc mixed data=final;
 title2 ' analysis to get untransformed means';
 class  date loc treat;
 model totalp =  loc  date(loc)
            treat treat*loc
            treat*date(loc) /predicted;
 lsmeans loc  date(loc)
            treat treat*loc
            treat*date(loc) /pdiff;
 make 'lsmeans' out=mmm noprint;
 make 'diffs' out=ppp noprint;
 make 'predicted' out=rrr noprint;
run;
%include 'a:pdmix612.sas';
%pdmix612(ppp,mmm);
proc univariate plot normal data=rrr;
 var _resid_;
```

SAS Program for Total P Analysis

```
run;
************************************************;


************************************************;
proc mixed data=final;
 title2 'analysis for transformed variable';
 class  date loc treat;
 model logp =  loc  date(loc)
            treat treat*loc
            treat*date(loc) /predicted;
 lsmeans loc  date(loc)
            treat treat*loc
            treat*date(loc)/ pdiff;
 make 'lsmeans' out=mmm noprint;
 make 'diffs' out=ppp noprint;
 make 'predicted' out=rrr noprint;
run;

%include 'a:pdmix612.sas';
%pdmix612(ppp,mmm);
proc univariate plot normal data=rrr;
 var _resid_;
run;
**************************************************;
```

SAS Program for PO_4 Analysis

```
title 'Analysis of Total PO4';
data one;
 informat date mmddyy8.;
 input Loc $ Year  Date  Precip Plot1 Plot2 Plot3  Plot4   Plot5 Plot6;
 format date mmddyy8.;
 year=year(date);
cards;
KTM   1997   07-03-97   2.18   0   85.83   60.54   0   0   0
KTM   1997   07-08-97   0.68   0   0   0   0   0   0
KTM   1997   07-15-97   0.65   0.00   0.00   0.00   0.00   0.00   0.00
KTM   1997   07-25-97   2.59   0.00   656.70   277.43   0.00   0.00   0.00
KTM   1997   08-15-97   0.24   37.39   9.07   13.20   4.65   4.94   7.70
KTM   1997   08-22-97   0.79   7.55   8.90   5.68   0.00   0.00   0.00
KTM   1997   09-16-97   0.51   0.00   3.41   8.71   0.00   6.59   0.00
KTM   1997   10-01-97   1.89   0.00   52.68   6.76   0.00   0.00   0.00
KTB   1997   07-03-97   2.18   783.88   225.54   10060.731   0   0   0
KTB   1997   07-08-97   0.67   11.79   0.00   88.40   0.00   0.00   0.00
KTB   1997   07-15-97   0.58   0.00   0.00   0.00   0.00   0.00   0.00
KTB   1997   07-25-97   2.5   0.00   0.00   7322.64   0.00   0.00   0.00
KTB   1997   08-15-97   0.24   9.10   12.69   8.69   5.18   16.15   0.00
KTB   1997   08-22-97   0.76   0.00   0.00   0.00   0.00   0.00   0.00
KTB   1997   09-16-97   0.49   0.00   15.13   10.35   0.00   0.00   0.00
KTB   1997   10-01-97   1.9   0.00   0.00   51.41   0.00   0.00   0.00
CTB   1997   07-09-97   0.25   7.73   19.01   93.85   0.00   0.00   0.00
CTB   1997   07-28-97   0.99   44.11   48.29   15.78   23601.48   1534.06   259.03
CTB   1997   08-08-97   0.5   12.50   113.09   604.79   45.71   47.63   140.78
CTB   1997   08-25-97   1.27   14.13   19.76   398.41   63.81   117.41   212.84
CTB   1997   09-11-97   0.36   62.65   103.07   93.08   57.13   68.34   44.81
CTB   1997   10-02-97   2.87   18.15   234.40   90.13   336.70   472.74   1576.01
;
proc print; run;

data notill; set one;
 treat='notill';
 drop plot1-plot6;
 totalpo4=plot1; output;
 totalpo4=plot2; output;
 totalpo4=plot3; output;
run;
data till; set one;
 treat='till';
 drop plot1-plot6;
 totalpo4=plot4; output;
 totalpo4=plot5; output;
 totalpo4=plot6; output;
run;
data final; set till notill;
 logpo4=log(totalpo4+1);
run;

*************************************************;
proc mixed data=final;
 title2 ' analysis to get untransformed means';
 class  date loc treat;
 model totalpo4 =  loc  date(loc)
          treat treat*loc
          treat*date(loc) /predicted;
 lsmeans loc  date(loc)
          treat treat*loc
          treat*date(loc) /pdiff;
 make 'lsmeans' out=mmm noprint;
 make 'diffs' out=ppp noprint;
 make 'predicted' out=rrr noprint;
run;
%include 'a:pdmix612.sas';
%pdmix612(ppp,mmm);
proc univariate plot normal data=rrr;
 var _resid_;
```

SAS Program for PO_4 Analysis

```
run;
**************************************************;

**************************************************;
proc mixed data=final;
 title2 'analysis for transformed variable';
 class  date loc treat;
 model logpo4 =  loc  date(loc)
           treat treat*loc
           treat*date(loc) /predicted;
 lsmeans loc  date(loc)
           treat treat*loc
           treat*date(loc)/ pdiff;
 make 'lsmeans' out=mmm noprint;
 make 'diffs' out=ppp noprint;
 make 'predicted' out=rrr noprint;
run;

%include 'a:pdmix612.sas';
%pdmix612(ppp,mmm);
proc univariate plot normal data=rrr;
 var _resid_;
run;
```

VITA

Teffany Lynn Rich was born on March 9, 1972 in Crossville, Tennessee. She grew up in Jamestown, Tennessee. She graduated from Sergeant Alvin C. York Agricultural Institute in May of 1990. In August of 1990 she entered Tennessee Technological University. In August of 1993 she transferred to The University of Tennessee and received a Bachelors of Science degree in Plant and Soil Science in December of 1995. In January 1996 she received an assistantship and entered the Graduate School at The University of Tennessee. In December of 1997 she completed the requirements for a Master of Science degree in Agricultural Engineering Technology.

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