

Characterization of On-Farm Phosphorus Budgets and Management in the Lake Champlain Basin



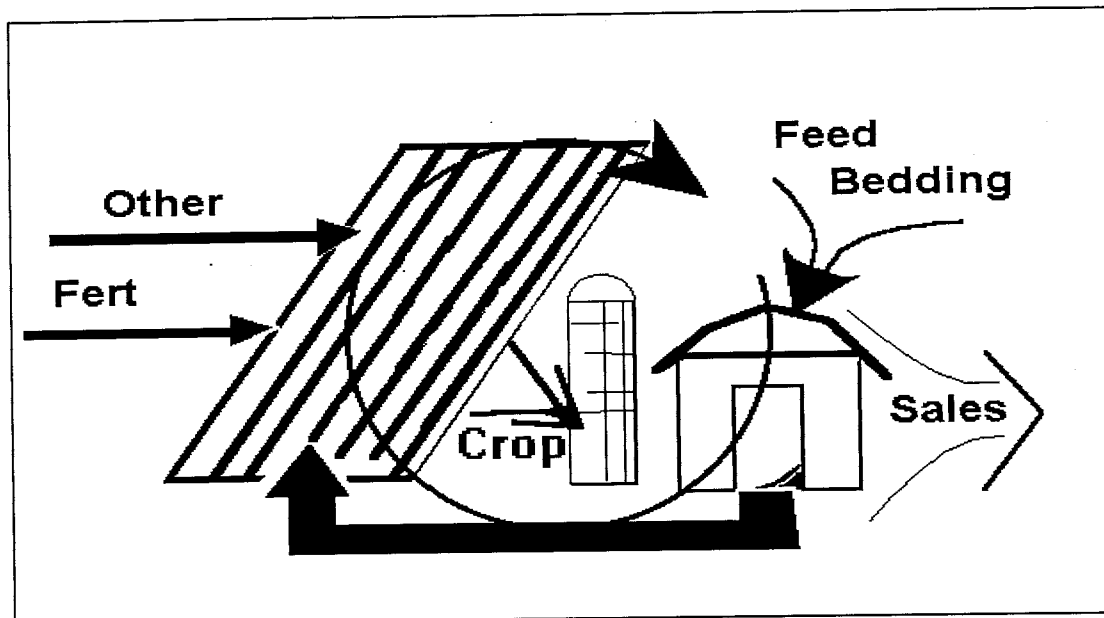
**Lake Champlain
Basin Program**

Prepared by
Robert D. Allshouse, Everett D. Thomas,
Charles J. Sniffen, Kristina Grimes, Carl
Majewski - Miner Agricultural Research Institute

for
Lake Champlain Management Conference

April 1997

Final Report



Adapted from Lanyon and Beegle, 1993

Characterization Of On-Farm Phosphorus Budgets And Management In The Lake Champlain Basin

April, 1997

Principal Investigators

Robert D. Allshouse, MSc

Everett D. Thomas, MSc

Charles J. Sniffen, PhD.

Kristina Grimes

Carl Majewski, MSc

Miner Agricultural Research Institute

Chazy, NY 12921

This technical report is the twenty-second in a series of reports prepared under the Lake Champlain Basin Program. Those in print are listed below.

Lake Champlain Basin Program Technical Reports

1. *A Research and Monitoring Agenda for Lake Champlain.* Proceedings of a Workshop, December 17-19, 1991, Burlington, VT. Lake Champlain Research Consortium. May, 1992.
2. *Design and Initial Implementation of a Comprehensive Agricultural Monitoring and Evaluation Network for the Lake Champlain Basin.* NY-VT Strategic Core Group. February, 1993.
3. (A) *GIS Management Plan for the Lake Champlain Basin Program.* Vermont Center for Geographic Information, Inc., and Associates in Rural Development. March, 1993.

(B) *Handbook of GIS Standards and Procedures for the Lake Champlain Basin Program.* Vermont Center for Geographic Information, Inc. March, 1993.

© *GIS Data Inventory for the Lake Champlain Basin Program.* Vermont Center for Geographic Information, Inc. March, 1993.
4. (A) *Lake Champlain Economic Database Project. Executive Summary.* Holmes & Associates. March 1993.

(B) *Socio-Economic Profile, Database, and Description of the Tourism Economy for the Lake Champlain Basin.* Holmes & Associates. March 1993

(B) *Socio-Economic Profile, Database, and Description of the Tourism Economy for the Lake Champlain Basin. Appendices.* Holmes & Associates. March 1993

© *Potential Applications of Economic Instruments for Environmental Protection in the Lake Champlain Basin.* Anthony Artuso. March 1993.

(D) *Conceptual Framework for Evaluation of Pollution Control Strategies and Water Quality Standards for Lake Champlain.* Anthony Artuso. March 1993.
5. *Lake Champlain Sediment Toxics Assessment Program. An Assessment of Sediment - Associated Contaminants in Lake Champlain - Phase 1.* Alan McIntosh, Editor, UVM School of Natural Resources. February 1994.

Lake Champlain Sediment Toxics Assessment Program. An Assessment of Sediment - Associated Contaminants in Lake Champlain - Phase 1. Executive Summary. Alan McIntosh, Editor, UVM School of Natural Resources. February 1994.
6. (A) *Lake Champlain Nonpoint Source Pollution Assessment.* Lenore Budd, Associates in Rural Development Inc. and Donald Meals, UVM School of Natural Resources. February 1994.

(B) *Lake Champlain Nonpoint Source Pollution Assessment. Appendices A-J.* Lenore Budd, Associates in Rural Development Inc. and Donald Meals, UVM School of Natural Resources. February 1994.

7. *Internal Phosphorus Loading Studies of St. Albans Bay. Executive Summary.* VT Dept of Environmental Conservation. March 1994.

(A) *Dynamic Mass Balance Model of Internal Phosphorus Loading in St. Albans Bay, Lake Champlain.* Eric Smeltzer, Neil Kamman, Karen Hyde and John C. Drake. March 1994.

(B) *History of Phosphorus Loading to St. Albans Bay, 1850 - 1990.* Karen Hyde, Neil Kamman and Eric Smeltzer. March 1994.

© *Assessment of Sediment Phosphorus Distribution and Long-Term Recycling in St. Albans Bay, Lake Champlain.* Scott Martin, Youngstown State University. March 1994.
8. *Lake Champlain Wetlands Acquisition Study.* Jon Binhammer, VT Nature Conservancy. June 1994.
9. *A Study of the Feasibility of Restoring Lake Sturgeon to Lake Champlain.* Deborah A. Moreau and Donna L. Parrish, VT Cooperative Fish & Wildlife Research Unit, University of Vermont. June 1994.
10. *Population Biology and Management of Lake Champlain Walleye.* Kathleen L. Newbrough, Donna L. Parrish, and Matthew G. Mitro, Fish & Wildlife Research Unit, University of Vermont. June 1994.
11. (A) *Report on Institutional Arrangements for Watershed Management of the Lake Champlain Basin. Executive Summary.* Yellow Wood Associates, Inc. January 1995.

(B) *Report on Institutional Arrangements for Watershed Management of the Lake Champlain Basin.* Yellow Wood Associates, Inc. January 1995.

© *Report on Institutional Arrangements for Watershed Management of the Lake Champlain Basin. Appendices.* Yellow Wood Associates, Inc. January 1995.
12. (A) *Preliminary Economic Analysis of the Draft Plan for the Lake Champlain Basin Program. Executive Summary.* Holmes & Associates and Anthony Artuso. March 1995

(B) *Preliminary Economic Analysis of the Draft Plan for the Lake Champlain Basin Program.* Holmes & Associates and Anthony Artuso. March 1995
13. *Patterns of Harvest and Consumption of Lake Champlain Fish and Angler Awareness of Health Advisories.* Nancy A. Connelly and Barbara A. Knuth. September 1995.
14. (A) *Preliminary Economic Analysis of the Draft Plan for the Lake Champlain Basin Program. Executive Summary - Part 2.* Holmes & Associates and Anthony Artuso. November 1995

(B) *Preliminary Economic Analysis of the Draft Plan for the Lake Champlain Basin Program - Part 2.* Holmes & Associates and Anthony Artuso. November 1995
15. *Zebra Mussels and Their Impact on Historic Shipwrecks.* Lake Champlain Maritime Museum. January 1996.
16. *Background Technical Information for Opportunities for Action: An Evolving Plan for the Future of the Lake Champlain Basin.* Lake Champlain Basin Program. June 1996

17. (A) *Executive Summary. Economic Analysis of the Draft Final Plan for the Lake Champlain Management Conference.* Holmes & Associates and Anthony Artuso. July 1996

(B) *Economic Analysis of the Draft Final Plan for the Lake Champlain Basin Management Conference.* Holmes & Associates and Anthony Artuso. July 1996
18. *Catalog of Digital Spatial Data for the Lake Champlain Basin .* Vermont Center for Geographic Information, Inc. September 1996.
19. *Hydrodynamic and Water Quality Modeling of Lake Champlain.* Applied Science Associates, Inc. July 1996.
20. *Understanding Phosphorus Cycling, Transport and Storage in Stream Ecosystem as a Basis for Phosphorus Management.* Dr. James P. Hoffmann, Dr. E. Allan Cassell, Dr. John C. Drake, Dr. Suzanne Levine, Mr. Donald W. Meals, Jr., Dr. Deane Wang. December 1996.
21. *Bioenergetics Modeling for Lake Trout and Other Top Predators in Lake Champlain.* Dr. George W. LaBar and Dr. Donna L. Parrish. December 1996.
22. *Characterization of On-Farm Phosphorus Budgets and Management in the Lake Champlain Basin.* Robert B. Allshouse, Everett D. Thomas, Charles J. Sniffen, Kristina Grimes, Carl Majewski - Miner Agricultural Research Institute. April 1997.

This report was funded and prepared under the authority of the Lake Champlain Special Designation Act of 1990, P.L. 101-596, through the U.S. Environmental Protection Agency (EPA grant #EPA X 001840-01). Publication of this report does not signify that the contents necessarily reflect the views of the States of New York and Vermont, the Lake Champlain Basin Program, or the U.S. Environmental Protection Agency.

Table of Contents

List of Figures and Tables	ii
Acknowledgments	iii
Executive Summary.....	1
Goal	5
Objectives.....	5
Literature Review.....	6
Nutrient Cycling on the Farm	7
Procedures	9
Phase 1	9
Phase 2.....	10
Data Collection.....	10
Phase 3	11
Results and Discussion	11
Farm Profiles	12
New York Farms:.....	12
Farm-11	12
Farm-12	13
Vermont Farms:	13
Farm-21	13
Farm-22	13
Farm-23	14
Farm-24	14
Farm-25	14
Soils, crops and topography	14
Animal density	15
Phosphorus use on cropland.....	17
Farm Balance.....	20
Summary	23
Recommendations.....	24
References	26
Individual farm evaluations	28
Appendices.....	30

List of Figures and Tables

FIGURE 1. NUTRIENT FLOW ON THE FARM (Adapted from Lanyon and Beegle, 1993)	8
TABLE 1. AVERAGE BALANCE OF N, P, AND K ON FARMS IN THE ST. ESPRIT WATERSHED PROJECT QUEBEC.....	8
TABLE 2. CHARACTERIZATION OF FARMS PARTICIPATING IN THE ON-FARM PHOSPHORUS STUDY.....	11
TABLE 3. SUB-BASIN AND DISTANCE UPSTREAM OF LAKE CHAMPLAIN VIA WATERWAY FOR SEVEN FARMS PARTICIPATING IN THE ON-FARM PHOSPHORUS STUDY.....	12
FIGURE 2. OVERALL CROP DISTRIBUTION FOR SEVEN FARMS IN THE LAKE CHAMPLAIN BASIN.....	16
TABLE 4. TYPE AND ANIMAL DENSITY FOR SEVEN FARMS IN THE LAKE CHAMPLAIN BASIN.....	16
FIGURE 3. TOTAL P_2O_5 USE ON CROPLAND.....	17
FIGURE 4. OVERALL DISTRIBUTION OF P_2O_5 FROM CHEMICAL FERTILIZER FOR SEVEN FARMS IN THE LAKE CHAMPLAIN BASIN.....	18
FIGURE 5. OVERALL DISTRIBUTION OF P_2O_5 FROM MANURE FOR SEVEN FARMS IN THE LAKE CHAMPLAIN BASIN.	18
TABLE 5. ANNUAL CORN PHOSPHORUS INPUTS, OUTPUTS, AND BALANCE.....	19
TABLE 6. ANNUAL LEGUME PHOSPHORUS INPUTS, OUTPUTS, AND BALANCE.	19
TABLE 7. ANNUAL GRASS PHOSPHORUS INPUTS, OUTPUTS, AND BALANCE.....	20
TABLE 8. ANNUAL NITROGEN AND PHOSPHORUS INPUTS, OUTPUTS AND BALANCES ON THE MINER INSTITUTE DAIRY FARM FOR 1992 AND 1993.....	21
TABLE 9. TOTAL INPUT, OUTPUT AND BALANCE FOR N,P, AND K.	22
TABLE 10. PHOSPHORUS IMPORTS AND EXPORTS PER ACRE OF CROPLAND AND BALANCE FOR SEVEN FARMS LOCATED IN THE LAKE CHAMPLAIN BASIN.....	23

Acknowledgments

The authors gratefully acknowledge the assistance of the following individuals:

The members of the Project Advisory Council:

Ms. Anita Deming, Cooperative Extension, Westport, NY

Mr. Donald Tetreault, Champlain, NY

Mr. Craig Altemose, Cooperative Extension, St. Albans, VT

Mr. Phil Benedict, Director, Vermont Dept. of Agricultural, Montpelier, VT

Mr. Jeff Carter, Cooperative Extension, Middlebury, VT

Mr. Richard Croft, District Conservationist, USDA/NRCS, Winooski, VT

Mr. Stu Gibson, Dept. Animal and Food Science, University of Vermont, Burlington, VT

Dr. William Jokela, Plant and Soil Science, University of Vermont, Burlington, VT

For assistance with key data:

Sara Cushing, Missisquoi Crop Association, St. Albans, VT

Paul Stanley, Paul C. Stanley Crop Management Services, E. Fairfield, VT

Susan Hawkins, Champlain Valley Corp Management Assoc., New Haven, VT

We would like to extend a special thank you to the participating farmers of this study. We appreciate all their efforts in recalling information, providing the necessary records, and answering the same questions several different times. But mostly we appreciate their unending patience and hospitality without which this study would not have been possible.

Executive Summary

Introduction

Clean water is the basis of Lake Champlain's economic, recreational, and cultural values. Agricultural non-point source (NPS) pollution, particularly phosphorus, have been identified as a key source of these substances entering Lake Champlain.

Issues of water and soil quality, as well as nutrient use and management have spurred interest in farm system planning. Improvement in any of the aforementioned issues requires an integrated approach to planning or a systems approach to analyzing farming systems. This approach focuses on the pattern and sequence of crops over time, management decisions relevant to the inputs and production practices used, operator skill level, education, goals, the quality of the soil and water, and the ecosystem within which the farm production occurs (Lanyon, 1992). A thorough analysis of the farming system is necessary to the development of policies and programs which will ultimately determine our farming future.

Recently there has been an increased interest in the area of farm mass nutrient balances which involve accounting for all farm inputs and outputs with the difference being the mass balance of the farm ($\text{INPUTS} - \text{OUTPUTS} = \text{BALANCE}$). Mass balances allow us to assess the transformations and transfers that occur in and between the various components of a farming system and to assess the efficiency of nutrient use within the system. An understanding of the dynamics of the system better enables us to improve soil and water quality.

Objectives and Approach

The objectives of this study were to:

- ✓ Conduct a detailed evaluation of the phosphorus balance on seven dairy farms representing both the New York and Vermont portions of the Lake Champlain Basin.
- ✓ Characterize the use, cycling, and fate of phosphorus on each representative dairy farm.
- ✓ Recommend methods to improve the efficiency of phosphorus use on the representative basin dairy farms.

Methods

During Phase-1, a Project Advisory Council was established. The membership of the council was made up of agricultural professionals representing the scientific and business communities, and farmers representative of the Basin. The council met to

characterize the size and scope of farms in the Lake Champlain Basin of Vermont and New York, and provided direction in selecting participating farms for the study.

Farms were selected that represented the range in size, type, management, and skill level of farms found within the Basin. Preference was given to farms participating in farm record-keeping systems.

Data relevant to this study consisted of characterization information, as well as crop and livestock production and sales data for a 12 month period. Data characterizing the farm included but was not limited to location, acreage, soil types and distribution, and cropping systems.

Crop information included field size, soil type, crop grown, phosphorus inputs, yield, and composition. Livestock information included breed, number, feed and mineral purchases, and milk and livestock sales.

This and other data provided a description of the flow and fate of phosphorus on each farm for the 12-month period. In addition it provided sufficient information to allow comparisons between farms and management styles.

Results

Seven farms, four in Vermont and three in New York, were originally chosen for the study. However, one NY farm withdrew from the study and an additional Vermont farm was added. Also, an additional year of data was obtained for one of the NY farms. Thus at the end of the study, the participants consisted of two farms in New York, one with one year of data and another with two consecutive years of data and five Vermont farms. These seven farms represented a total of 1,877 acres and 978 lactating cows.

Farms ranged in size from 378 cropland acres to 131 acres. There were five farms raising Holsteins, one farm raising both Holsteins and Jerseys, and one farm raising only Jerseys. Yearly milk sales ranged from 20,301 lb/cow to 9,968 lb/cow. Farm location, measured as distance from Lake Champlain via waterway, ranged from 30 miles to a farm located adjacent to the Lake.

There was considerable variation in soil type and drainage among farms. Soil topography was less variable. Three farms have over 70% of cropland with 0 - 3% slope and only one farm has a significant amount of cropland with a slope greater than 8%.

The only hill-farm, located 30 miles upstream of the Lake, has mostly well drained soil. Five farms all have a considerable portion of poorly or somewhat poorly drained soil. One farm has a large proportion of well drained soil.

All farms with the exception of the hill-farm raise a combination of grass, legumes, and corn. The proportion of legumes and grass grown appears dictated by soil characteristics and climate. One farm is diverse, growing corn, alfalfa, grass, barley, and soybeans. In general, the distribution of crops on the seven farms is 35% corn, 35% ; legume, 23% grass, and 7% other crops.

Animal density (1000 lb mature cow/ acre) has been cited as one measure of water pollution potential on livestock farms. Farms with high animal density have less land area available to adsorb the animal waste produced. Animal density ranged from low to high. Three farms had a high density and four farms had a low density.

Field Balance

Phosphorus applied to corn fields during the spring accounted for 78.9% of the total fertilizer P and 39.9% of the total manure P used on all seven farms. Net P balance (Inputs - Outputs) for all corn, legumes, and grass were all positive. A positive balance indicates an accumulation of phosphorus in the soil. However, the weighted balance, adjusted for crop distribution, for all seven farms in the study was 5.24 lb P / A of cropland.

Net balance was higher for corn than either legumes or grass, 10.37 vs 2.89 or 1.66 lb P / A, respectively. However, the range among farms was large in all three crop categories. For corn the range was -5.81 to +27.35 lb P retained / A.

Farm Balance

The seven farms imported a total of 27 tons of P during 1995, 67% in the form of livestock feed and bedding. These same farms exported nine tons of P, seven tons in milk and one ton of P in both livestock and crops. The net balance was 68.15% of imported P retained on the farm.

Retained P as a percent of the total import P ranged from 40.1% to 75.5%. The farm having the lowest P retention also purchased no fertilizer P in 1995. This, according to the owner, was an anomaly and was based on economic decision. Under other circumstances fertilizer P would have been purchased.

The second lowest P retention (52.1%) was that of the hill-farm which grows no corn and uses pasture. The highest P retention was that on a farm located in an area of low inherent soil fertility and poor drainage. These characteristics delay planting dates, increase fertilizer requirement, and reduce yields. These factors combine to increase inputs and decrease outputs, resulting in increased P retention.

Summary

What is the fate of nutrients brought on to the farm? Is the phosphorus retained a potential pollutant? What represents an “*acceptable*” mass balance?

Nutrients arrive on farms in a variety of ways and forms. On farms in this study these nutrients arrive predominantly through purchased feed. Increasing production of legumes on the farm will reduce off-farm purchases of protein feeds and nitrogen fertilizers. Application of manure to legume stands to supply P can also reduce farm purchases of P fertilizer.

What is acceptable? A mass balance is essentially a measure of inefficiency. Therefore, it can only be as good as the least efficient unit in the system. In the case of the dairy farm we are restricted by the cow's efficiency in converting nutrients into milk. The inefficiency of P use ranges from 69% to 80% (Morse et. al., 1992). On dairy farms mass balances lower than these figures are attainable by selling crops as well as milk.

Mass balances of nutrients in agricultural systems can provide powerful tools to ascertain trends in nutrient use and provide mechanisms by which management changes may affect environmental impact. Whole farm nutrient balances can provide an overall view of the system balance and yearly trends, but only offer limited information on the dynamics of nutrient use within the specific units of a farm. Accurate use requires not only estimates of mass balance but current and past management, farm status, and information regarding the source of reliable and useful estimates.

This study is a “snap-shot” of the situation on seven farms in 1995. Studies conducted at Miner Institute indicate that management changes can significantly impact the net flux of nutrients in a given year. The net flux of phosphorus on any given dairy farm is a function of animal density and the level of milk production.

Characterization of on-farm Phosphorus Budgets and Management in the Lake Champlain Basin

Goal

Assist the Lake Champlain Basin Program in reducing non-point source discharges of phosphorus by characterizing and evaluating on-farm phosphorus budgets and developing options for reducing potential phosphorus pollution from Basin dairy farms.

Objectives

The objectives of this study are:

- ✓ Conduct a detailed evaluation of the phosphorus balance on seven dairy farms representing both the New York and Vermont portions of the Lake Champlain Basin.
- ✓ Characterize the use, cycling, and fate of phosphorus on each representative dairy farm.
- ✓ Identify economic or sociological factors which affect the on-farm nutrient cycle on each representative dairy farm.
- ✓ Identify on-farm opportunities to limit the loss of phosphorus to the environment.
- ✓ Recommend methods to improve the efficiency of phosphorus use on the representative basin dairy farms.

Literature Review

Dairy farms in the Champlain Basin are becoming fewer, but the remaining farms continue to increase in size. The relatively flat topography and almost stone-free lake-laid clay soils have resulted in large crop fields, greater efficiency in crop production, and large dairy farm size. As owners of smaller farms retire from farming, much of the cropland is quickly acquired by neighboring dairy farms. Soon after purchasing more cropland, a new dairy barn or addition to the present barn appears. Clinton County (NY), for instance, has the same number of dairy cows (20,500) as it did twenty years ago (NY State Dept. of Agriculture and Markets, 1992). However, in 1974 there were 415 dairy farms, while now there are about 220. Dairy cow numbers per farm increased from 49 to 93 (Census of Agriculture, 1974, NY State Dept. of Agriculture and Markets, 1992). The Holstein breed has to a great extent replaced smaller dairy breeds, and the Holstein breed itself is producing larger cows. For instance, the Miner Institute dairy barn when designed in 1970 had stalls sized correctly for the average Holstein. Twenty-five years later, the stalls are too small for Holsteins. Therefore, the 93 cows on the average farm in 1992 represented considerably greater biomass per head--and therefore greater nutrient input and output--than the 49 cows on the average N.Y. dairy farm in 1974.

There is no sign that increases in herd size will cease; indeed, some of the highest producing dairy herds are also the largest. For instance, the top ten DHI herds for milk production in Clinton County average 188 dairy cows per farm, while the next ten average 89 cows per farm (Northeast DHI, 1994). Larger farms are more efficient, while allowing for division of management responsibilities. This increase in herd size is not only a Northeastern phenomenon, rather it is occurring in almost all dairying regions of the U.S. (Tamminga, 1992).

With larger herd size and greater concentration of animal numbers, nutrient loading and the potential for nutrient losses to the environment increase (Frink, 1969). Over the years, dairy cows have also been fed a greater portion of total dry matter intake as grains and grain by-products which are more nutrient-dense, containing 50% to 100% more phosphorus than locally grown forages. Most of these grains are grown in the Midwest, and therefore represent new nutrients coming into the Northeast, not a recycling of existing nutrients. During the past thirty years, the amount of grain fed on the average Pennsylvania dairy farm has increased almost tenfold (Lanyon, 1992). The average dairy farm in the Northeast brings far more nutrients onto the farm in the form of fertilizer, feed, minerals, detergents, and purchased crops than it markets as milk, meat, and cash crops. On a typical Northeastern U.S. dairy farm, for every three pounds of N, P, and K inputs, only about one pound of nutrient leaves the farm as milk, meat, and crops. Klausner (1993) reports that about 65% of N, 88% of P, and 90% of K remains on the farm. As long as the animal density remains the same, these percentages are valid across a wide range of herd sizes.

Nutrient Cycling on the Farm

Issues of water and soil quality, as well as nutrient use and management have spurred interest in farm system planning. Improvement in any of the aforementioned issues requires an integrated approach to planning or a systems approach to analyzing farming systems. This approach focuses on the pattern and sequence of crops over time, management decisions relevant to the inputs and production practices used, operator skill level, education, goals, the quality of the soil and water, and the ecosystem within which the farm production occurs (Lanyon, 1992). This approach is necessary to the development of policies and programs which will ultimately determine our farming future.

There has been considerable interest in the area of farm mass nutrient balances. Development of a farm mass nutrient balance involves accounting for all farm inputs and outputs with the difference being the mass balance of the farm ($\text{INPUTS} - \text{OUTPUTS} = \text{BALANCE}$). This is illustrated in Figure 1.

Mass balances allow us to assess the transformations and transfers that occur in and between the various components of a farming system and to assess the efficiency of nutrient use within the system, better enabling us to improve soil and water quality.

In 1993, the National Research Council published estimates for the mass balance of N and P for all harvested cropland across the U.S for 1987. The P mass balance was 63% of total inputs. This means that in 1987, 63% of the P inputs were either put into storage on the farm or became a threat to water quality. Phosphorus is relatively immobile in the soil, and a positive mass balance would result in a build-up of soil P levels over time (McCollum, 1991). The increase in soil P occurs principally in the plow layer with conventional tillage and at the soil surface with no-till (Lang, 1994). Phosphorus immobility and its being sequestered in the plow layer act in concert to increase the potential for pollution resulting from surface runoff, but not leaching.

In the NRC study, the mass balance for N ranged from 33% to 40%. The variation was due to the range in efficiencies with which legumes can fix atmospheric N. However, 35% of the total N harvested was accounted for by legumes, which receive very little N fertilizer. If legumes were removed from the equation the mass balance for N would range between 60 and 65%.

The NRC study provides a national perspective on the situation but provides little useful information toward regional or local benefit. Farming systems are highly variable across and within regions. Therefore, to be of greatest benefit a mass balance should be conducted on a farm or local basis.

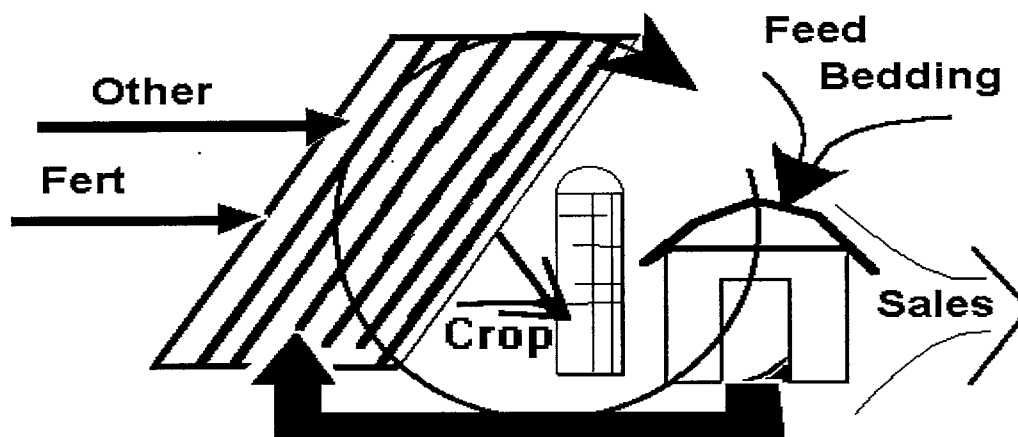


FIGURE 1. NUTRIENT FLOW ON THE FARM (Adapted from Lanyon and Beegle, 1993)

Lanyon and Beegle (1989) conducted a mass balance study on a typical 138-acre dairy farm in Pennsylvania. They found that 53% of input P and 86% of the input N remained on the farm. Fertilizer accounted for 23% and 37% of the input N and P, respectively. In the national estimate fertilizer inputs made up 45% and 79% of the input N and P, respectively.

In the St. Esprit, Quebec watershed, nutrient balances have been done on 12 farms (Léger, 1996. Personal Communication). These represent a cross-section of the types of farms found in the watershed. These farms, although diverse by U.S. standards, could be grouped into one of the following categories: dairy, swine, poultry, vegetable, or mixed

TABLE 1. AVERAGE BALANCE OF N, P, AND K ON FARMS IN THE ST. ESPRIT WATERSHED PROJECT QUEBEC.

Catagory	N	P	K
	----- % Retained -----		
Mixed	52.9	39.6	52.8
Vegetable	41.5	65.3	52.1
Poultry	60.6	46.2	62.9
Swine	25.1	5.9	63.7
Dairy	69.8	75.7	67.0

farming. The average balance for N, P, and K for each category is shown in Table 1.

Although the farms were grouped by category, there was a large degree of overlap. There were two farms that were predominately swine farms. However, one of the farms raised broilers in addition to the swine. The P balance for that farm was 5.8%. The other swine farm also raised vegetables. The P-balance for this farm was 68.7%

Of the 12 farms, four were predominately dairy. However, most of the dairy farms raised non-dairy feed crops as well. The range in P-balance for the four dairy farms was from 62.4% to 86.0%

Nitrogen and phosphorus are recognized as posing serious threats to water quality nationwide. Pennsylvania is currently focusing on programs to reduce both nitrogen non-point and point source pollution (Pennsylvania Department of Environmental Resources, 1993), while the Lake Champlain Basin Program cites phosphorus as the most serious nutrient threat to water quality (Lake Champlain Management Conference, 1993).

Farms are not without options to improve the efficiency of the nutrient cycle on the farm. According to Van Horn (1992), dairy farmers can influence the amount of P excreted by cows through controlling mineral content of the diets they feed. Decreasing dietary P from 0.60% to 0.40%, for instance, reduced annual P excretion by 29% without adversely affecting milk production.

While it seems unlikely that a typical Champlain Basin dairy farm which purchases most of its grain and spreads manure on its own cropland can achieve a "perfect" phosphorus balance, there is considerable difference in efficiency between dairy farms. Several USDA/SCS studies in Vermont estimated that phosphorus loading ranged from less than one to almost ten pounds of phosphorus per 1000# animal unit per year (USDA/SCS 1983, 1985a, 1985b). It is obvious from these numbers that considerable improvements in phosphorus efficiency can be achieved on many farms simply by applying proven nutrient management techniques.

Procedures

Phase 1.

During this phase a Project Advisory Council was established. This council met to characterize the size and scope of farms in the Lake Champlain Basin of both Vermont and New York, and select representative farms from both states. Members of the Project Advisory Council were agricultural professionals representing the scientific and business communities, and farmers representative of the basin profile. The council was responsible for selecting participating farms, assisting in summarizing the farm information, and developing surveys to facilitate the acquisition of necessary information.

Farms were selected to represent the range of type, size, management and skill level for farms within the basin. Preference was given to farms participating in farm record-keeping systems. To facilitate comparisons both confinement and pasture management systems were included. Farms were selected to represent the diversity of management styles inherent to the Basin.

Phase 2.

Phase 2 consisted primarily of data and information acquisition and analysis. Relevant data and related socio-economic information were obtained through a extensive series of on-farm interviews.

Data Collection.

Data relevant to this study consisted of characterization information, as well as crop and livestock production and sales data for a 12 month period. Our current research has shown the following factors to be significant in the determination to the phosphorus balance on the Miner Institute dairy farm:

Characterization:

- farm location
- acreage
- management type
- soil types and distribution
- soil erosion potential
- record-keeping system
- livestock categories and numbers
- crop types
- cropping systems
- waste management
- farm history
- manure application and rate
- crop composition and yield
- crop inventory
- crop fate (used on site or sold)

Crop Information:

- field acreage
- soil type
- soil fertility level
- fertilizer purchases
- fertilizer analysis and application rate

Livestock Information:

- breed
- housing system
- management
- purchases and analyses for:
 - * grain
 - * purchased forage
 - * minerals
 - * bedding
- manure management
- purchases and sales of livestock
- milk sales

This data provides a description of the flow and fate of phosphorus on each farm for the 12-month period. In addition it provides sufficient information to allow comparisons between farms and management styles.

The detail and frequency with which data was obtained was dependent on each farm's record-keeping system.

Nutrient composition of farm inputs (eg. grain, fertilizer, etc.) was obtained from guaranteed analysis. When available, forage analysis were used to determine the nutrient composition of purchased or sold forages. However, where commercial analyses are

unavailable standard values for nutrient composition of forages were used. Information on soil fertility was obtained through farmer-provided soil analyses.

Units of measure are reported in pounds or tons. Purchases and sales of fertilizer, grain, and forage is reported on a dry basis, whereas livestock purchases and sales and milk sales are reported on an as-is basis. Nutrient phosphorus will be discussed as either elemental phosphorus (P) or available phosphorus (as P_2O_5). To convert P_2O_5 to P divide by 2.3.

Phase 3.

Opportunities for reducing phosphorus loss on individual farms were identified and recommendations for enhancing the efficiency of phosphorus utilization formulated.

Results and Discussion

Seven farms, four in Vermont and three in New York, were originally chosen for the study. However, one NY farm withdrew from the study and an additional Vermont farm was added. Also, an additional year of data was obtained for one of the NY farms. Thus at the end of the study, the participants consisted of two farms in New York, one with one year of data and another with two consecutive years of data, and five Vermont farms. These seven farms represented a total of 1,877 acres and 978 lactating cows.

Every effort was made to include a variety of management practices, thereby obtaining a representative cross-section. The average farm size was 268 acres and had 140 lactating cows (Table 2.)

TABLE 2. CHARACTERIZATION OF FARMS PARTICIPATING IN THE ON-FARM PHOSPHORUS STUDY.

State	Farm Code	Cropland acres	Lactating Cows	Type	Manure Handling
NY	11	378	95	Free-stall	Liquid, 6-Mo storage
NY	12	321	253	Free-stall	Liquid, daily spread
VT	21	377	250	Free-stall	Liquid, 6-Mo storage
VT	22	131	95	Tie-Stall	Semi-solid, 6-Mo storage
VT	23	174	80	Tie-stall	Liquid, 6-Mo storage
VT	24	217	120	Tie-stall	Liquid, 6-Mo storage
VT	25	279	85	Tie-stall	Liquid, 6-Mo storage
Total		1877	978		

All farms except Farm-22 raise Holstein cattle and corn for either grain or silage as a part of their crops. Farm-22 raises Jersey cattle and makes extensive use of pasture and grassland. Three of the farms are located on relatively flat, clay soils within seven

TABLE 3. SUB-BASIN AND DISTANCE UPSTREAM
OF LAKE CHAMPLAIN VIA WATERWAY
FOR SEVEN FARMS PARTICIPATING IN
THE ON-FARM PHOSPHORUS STUDY.

Farm Code	Sub-basin	Distance, miles
11	Saranac/Chazy	4
12	BoquetAusable	6
21	Winooski	27
22	Missisquoi	30
23	Lamoille/Grand Isle	7
24	Lamoille/Grand Isle	7
25	Lamoille/Grand Isle	<1

miles of Lake Champlain. Table 3 provides the general location for each farm relative to sub-basin and approximate distance from the lake via the nearest waterway.

Figures describing the distribution of soil textural, drainage, and slope classes for each individual farm are located in the appendix. Figures describing the distribution of crops on individual farms are also found in the appendix.

Farm Profiles

New York Farms:

Farm-11

The farm consists of 378 acres of cropland and a herd of 65 lactating Holsteins and 30 lactating Jerseys in a free-stall. The dairy herd has an annual production of 17,181 lbs/cow. Manure produced by the dairy is stored in an earthen lagoon which has a 6-month storage capacity. Manure is spread during the fall and early summer. Of the 378 acres of open cropland, 35.4% are used for corn silage production, 34.4% for alfalfa production, 22.5% for grass, and 7.7% for producing rye for straw.

One measure of the variation within and among farms is the number and distribution of soil types encountered on a farm. These differences can be used to compare farms and fields within a farm. Two farms could have the same proportion of coarse soil on each farm. However each farm will have different management challenges if on one farm the coarse soil acreage is composed of six different soil types and only two types on the other farm.

Fifty percent of the productive soil on this farm is of medium texture. Six soil types constitute 302 acres or 80% of the total cropland on this farm. Of this, 217 acres have moderate to severe limitations for field crop production due primarily to seasonal wetness. However, tile drainage has been installed in much of this acreage to reduce the limitations and improve soil productivity.

Farm-12

The Farm consists of 321 acres and a herd of 250 lactating Holsteins. Animals are housed in a free-stall which was originally a traditional tie-stall barn. This herd has an annual production of 20,301 lb of milk per cow. Manure is collected daily and spread on the fields. Of the total crop acreage, 41.7% is used to produce corn for silage, 21.2% is used to produce grass, and the remaining 37.1% is used to produce alfalfa for either hay or silage. Like Farm-11, approximately 50% of the soil is of medium texture. However, 70% of the soil is comprised of only four soil types which have moderate limitations for the production of field crops. Unlike Farm-11, crop production is limited not due to seasonal wetness but to the coarse soil texture resulting in excessive drainage.

Vermont Farms:

Farm-21

This farm consists of 377 acres of cropland located in the Winooski river valley. The farm milks 200 Holsteins and produces 22,664 lb of milk annually per cow. Animals were housed in a free-stall converted from a conventional tie-stall. Manure is stored in an earthen lagoon having a 6-month storage capacity. Corn and alfalfa made up 46% and 48.3% of the total acreage, respectively. The remaining 5.7% of the cropland was planted to grass.

Approximately 88% of the total cropland is of medium soil texture. The majority of the soil, 62%, is of the Hadley soil series, a highly productive agricultural soil. It has only a slight limitation for agricultural production due to the potential for flooding.

Management decisions relative to crops and fertilizer use are made with the assistance of a crop advisor. This farm has been a member of a crop management association since 1989.

Farm-22

This is a hill-farm raising Jerseys on pasture. The farm consists of 131 acres and milks 95 head in a tie-stall barn. Annual herd production is 9,968 lb per cow. Manure is stored in an earthen/wood storage facility. Manure is removed and spread during the cropping season, late April through October. The only crops grown are grasses and grass/legumes for hay or silage.

The predominant soil texture is moderately coarse. Three soil types, Stowe, Missisquoi, and Peru, make up 60% of the acreage on this farm. Limitations for agricultural use vary from moderate to severe due to either soil problems, both wetness or excessive drainage or erosion potential depending on the soil type and slope. This farm has been a member of a crop management association since 1987.

Farm-23

This farm consists of 173 acres of cropland in the Jewett brook watershed. The herd of 80 lactating Holsteins produced 14,119 lb of milk annually per cow. Cows are housed in a tie-stall. Manure is stored in an earthen lagoon which has a 6-month storage capacity. Crop production consisted of corn for grain and silage (26%), grass for hay, silage, or pasture (61%), and clover/grass mixture for hay and silage (13%).

Soils are medium textured (92%) silty loams, Binghamville and Scantic series. These soils are characterized as deep, level, and poorly drained. Limitations for use in agricultural production are related to drainage and delayed planting.

Farm-24

This farm is in the same watershed as Farm-23. It consists of 217 acres of cropland, 43% used to produce corn, 47% for alfalfa production, and 10% as grassland for pasture or hay. The dairy herd, 120 Holsteins, produced 16,177 lb of milk per cow annually. Manure is stored in an earthen lagoon.

This farm is a neighbor to Farm-23 and is owned by the same family. The owner works closely with both the county extension agent and soil conservationist when planning his cropping strategy. Soil characteristics are similar, predominantly medium textured (87%), and 50% of the acreage is silt loam of either the Scantic or Birdsall series. Limitations to agricultural production are similar to those of Farm-23.

Farm-25

Farm 25 is located on the shore of Lake Champlain. Although considered a dairy farm, milking 85 Holsteins, this farm has a greater diversity of crops than the other participating farms. Cropland consists of 278 acres of owned and rented land. The cropland was divided between corn for grain and silage (25%), alfalfa (22%), soybeans (18%), barley (18%), and mixed grass and clover (17%). This farm has been a member of a crop management association since 1994.

Annual milk production per cow was 10,636 lb. Manure solids were composted and some composted manure was marketed. Milkhouse waste and manure liquids were retained in an earthen lagoon. This dairy effluent was used on corn in the irrigation water.

Approximately 60% of the soil is Covington silty clay and 24% is Kendaia silt loam. These soils are characterized as level, deep, and poorly drained. Limitations for agriculture are moderate to severe due to drainage problems.

Soils, crops and topography

The seven farms have considerable differences in soil type and drainage, but much less variation in field topography. Three farms have over 70% of cropland with 0-3%

grade, and only one has a significant portion of cropland with more than 8% slope. The hill farm not surprisingly has mostly well-drained soils, while the other six farms all have a considerable proportion of poorly and somewhat poorly drained soils. While erosion is certainly a potential problem on the hilly farm, 100% of this land is in grass sod.

The farm operators have made crop choices which in many cases are a compromise between the forage and grain needs of the dairy herd and the capability of their soils. For this reason, all but the hilly farm devote a significant portion of their crop acreage to corn, and five of the farms grow a considerable amount of alfalfa. One farm which has flat, poorly drained soil cannot grow alfalfa, and therefore grows grass and corn. Figure 2 illustrates the distribution of crops grown on the seven farms in the Lake Champlain Basin.

Animal density

One of the most often cited measures of water pollution potential on livestock farms is the animal density in 1000# units per acre of cropland. A good rule of thumb for a dairy farm which raises its own replacements is that one milk cow plus her replacement equals two 1000# animal units. Cornell University agronomist Stuart Klausner has categorized nutrient management by animal density for three crop rotations: corn-legume, corn-grass, and grass. For each animal density and each crop rotation, he recommends a maximum number of animal units per tillable acre. The assumption is that farms with considerable grass land can sustain higher animal densities than farms with a crop rotation of corn and legumes. We suggest that a more meaningful figure is not acres of cropland, but acres of cropland *which will be manured*. The Miner Institute cropland is a good example: While Miner Institute has 365 acres of cropland, at least 50 acres is subject to spring flooding. Nutrient management, especially manure application, is severely restricted on these acres. Another 40 acres adjoins a large laboratory complex, and manuring this land is possible only when the manure can immediately be incorporated. Therefore, since in most years only 275 of the 365 can be manured, *effective* animal density per acre of cropland is increased.

The animal density for each farm is presented in Table 4. As can be seen by the above table, animal density on the seven farms varies from low to high. Note that an animal density of 1.2 AU/acre is considered low on Farm-22 which has all grass, while 1.3 AU/acre is considered high on Farm-21 which has corn and legumes. The table is only an approximation, since several of the farms labeled "corn-legume" actually have some grass. What should not be overlooked, however, is that according to accepted guidelines, three of the farms studied have high animal densities.

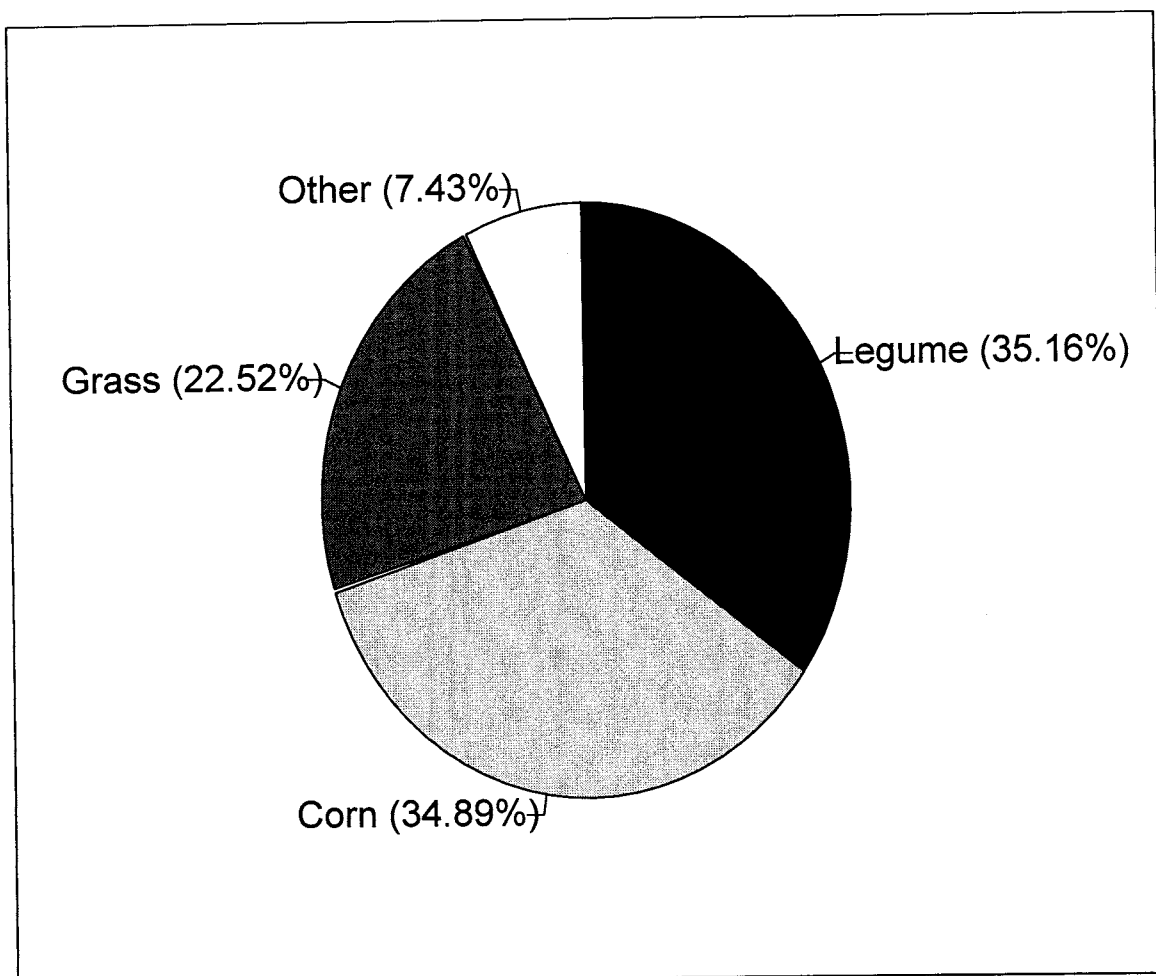


FIGURE 2. OVERALL CROP DISTRIBUTION FOR SEVEN FARMS IN THE LAKE CHAMPLAIN BASIN.

TABLE 4. TYPE AND ANIMAL DENSITY FOR SEVEN FARMS IN THE LAKE CHAMPLAIN BASIN.

Farm Code	Type	A.U./Acre	Density
11	Corn-legume	0.5	Low
12	Corn-legume	1.6	High
21	Corn-legume	1.3	High
22	Grass	1.2	Low
23	Corn-grass	0.9	Low
24	Corn-legume	1.1	High
25	Corn-legume	0.6	Low

Phosphorus use on cropland

Figure 3 shows the rate of application of total P_2O_5 from both manure and fertilizer on each of the seven farms in this study. Clearly, Farm-12 had the highest application rate of total P_2O_5 . However, Farm-24 had the highest application rate of fertilizer P_2O_5 .

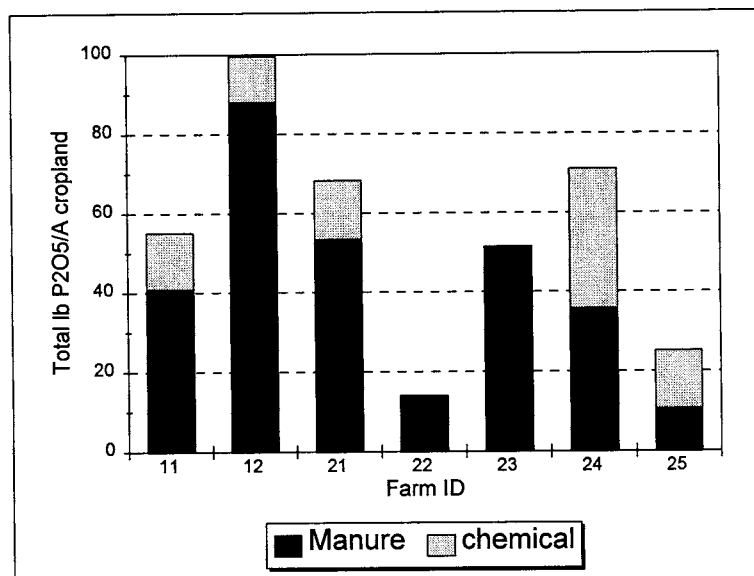


FIGURE 3. TOTAL P_2O_5 USE ON CROPLAND.

Most of the fertilizer P used on these farms was applied to corn at planting time (Figures 4 and 5). Five of the six farms growing corn applied fertilizer P at rates ranging from 11.6-26.6 lb of P per A of fertilizer P (Table 5). Only one farm used more than a small amount of P on legumes (Table 6) or grasses (Table 7). Manure P was much more. Four of the six farms growing grass applied manure to this crop.

Nutrient P inputs from manure to corn fields ranged from 20% to 100% of total P inputs. The average was 63.3% for the seven farms in the study. This application rate provided more than adequate P for corn production. Manure P supplied almost 90% as much P as was removed by the crop. This suggests that, on the average, only small fertilizer applications were necessary.

In terms of total P applied to corn, only two farms, Farm-11 and Farm-25, harvested more phosphorus than was applied. On the average, there was a net

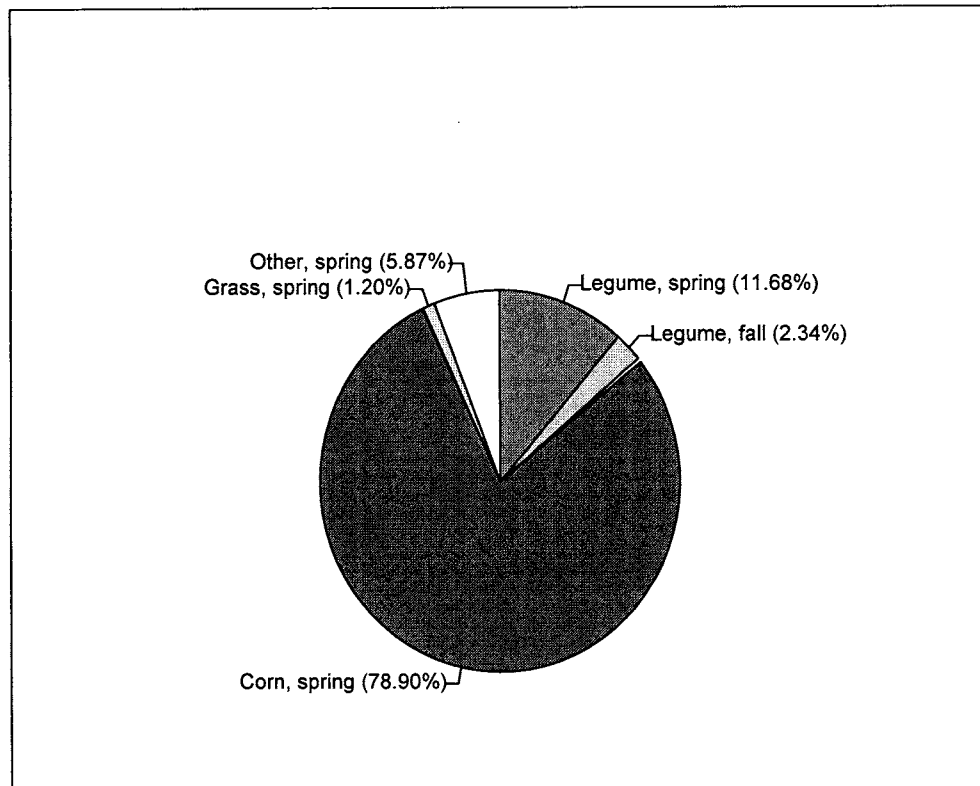


FIGURE 4. OVERALL DISTRIBUTION OF P₂O₅ FROM CHEMICAL FERTILIZER FOR SEVEN FARMS IN THE LAKE CHAMPLAIN BASIN.

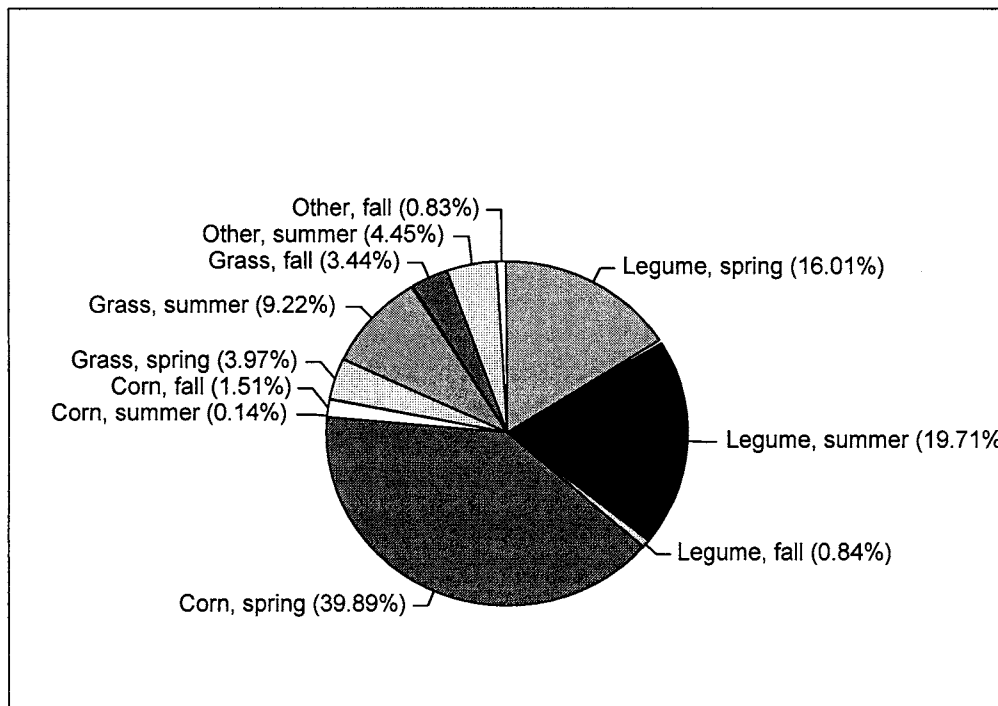


FIGURE 5. OVERALL DISTRIBUTION OF P₂O₅ FROM MANURE FOR SEVEN FARMS IN THE LAKE CHAMPLAIN BASIN.

TABLE 5. ANNUAL CORN PHOSPHORUS INPUTS, OUTPUTS, AND BALANCE.

	New York		Vermont				Basin Average
	11	12	21	23	24	25	
InPuts	----- lb of P / A -----						
Fertilizer	15.84	11.99	11.59	0.00	26.55	13.30	13.21
Manure	4.01	42.59	26.21	32.62	28.72	1.13	22.54
Output							
Crop	25.67	27.22	31.89	23.92	28.46	15.21	25.40
Balance							
In-Out	-5.81	27.35	5.92	8.70	26.81	-0.77	10.37
Purchased							
(In-Out)	-9.83	-15.24	-20.30	-23.92	-1.91	-1.91	-12.19

TABLE 6. ANNUAL LEGUME PHOSPHORUS INPUTS, OUTPUTS, AND BALANCE.

	New York		Vermont				Basin Average
	11	12	21	23	24	25	
InPuts	----- lb of P / A -----						
Fertilizer	1.73	0.00	1.96	0.00	12.86	9.70	4.38
Manure	8.81	40.35	17.89	19.65	14.39	17.21	19.72
Output							
Crop	18.49	19.68	24.72	22.46	27.38	14.46	21.20
Balance							
In-Out	-7.96	20.67	-4.88	-2.82	-0.14	12.46	2.89
Purchased							
(In-Out)	-16.76	-19.68	-22.76	-22.46	-14.52	-4.75	-16.82

accumulation of P on all fields. Again there was a range in values depending upon the farm and the crop being considered.

Individual crop balances provide a means to determine the allocation of resources to any given crop. However, these values cannot be used directly to make inferences concerning the whole farm. An example is Farm-21; the simple arithmetic mean for the net P balance per acre would be 0.52 lb P / A. However, if we use the weighted mean, corrected for the distribution of crops, then the value is 0.12 lb P / A. Caution must be exercised in drawing inferences from these values.

Making adjustments for crop distribution is not the only concern. As discussed in the farm descriptions, the seven farms are located on soils which differ in their response to management. In applying this information across the Lake Champlain Basin, adjustments would be required for inherent soil fertility.

For instance, it would be convenient to use the average net balance for each crop to arrive at an average for the entire basin for all crops. A simple average for the three crops presented is a value of 4.97 lb of P accumulating per acre each year. However, the

TABLE 7. ANNUAL GRASS PHOSPHORUS INPUTS, OUTPUTS, AND BALANCE.

	New York		Vermont				Basin Average
	11	12	22	23	24	25	
InPuts			----- lb of P / A -----				
Fertilizer	1.37	0.00	0.00	0.00	4.68	0.00	1.01
Manure	25.83	7.49	7.92	18.14	0.00	0.00	9.90
Output							
Crop	10.57	6.50	13.53	13.54	2.36	8.97	9.25
Balance							
In-Out	16.63	0.98	-5.60	4.60	2.31	-8.97	1.66
Purchased							
(In-Out)	-9.20	-6.50	-13.53	-13.54	-2.31	-8.97	-9.01

real value is actually 5.24 lb P / year, a weighted average dependent upon the proportions of each crop in the region. What is the impact of distribution of farm type? Assume that 75% of the farms located in the Basin have a net retention of P of 12.48 lb and the remaining 25% have a retention of -2.00 lb P. The arithmetic mean is 5.24 lb P but the weighted average is 8.86 lb P / A.

Farm Balance

Using detailed farm records, a farm nutrient mass balance was conducted for 1992 and 1993 for the Miner Institute farm (Table 8.). The N mass balance was 76% and 83% for 1992 and 1993, respectively. For P the mass balance was 72% and 80% for 1992 and 1993, respectively.

It would appear that since the nutrient balance for both N and P increased between 1992 and 1993, the potential to pollute may have increased as well. However, what is missing are the changes in management that had occurred during the two years. Two decisions were made; one was to sell some low-producing cows and increase the inventory of heifers. This had the effect of increasing the purchased feed inputs while having little effect on milk production outputs. The second decision was to increase manure use on alfalfa land, thereby reducing purchased fertilizer. The result was a 0.07 ton decrease in purchased P fertilizer. In 1992, 111 acres of alfalfa were harvested, whereas 108 acres were harvested in 1993. N-fixation is a function of the N yield; therefore, since N-fixation was higher in 1993 than in 1992 on essentially the same acreage, we must conclude that, on a per acre basis, crop yields in 1993 were higher than in 1992.

The reduced cow numbers resulted in reduced consumption of farm-produced feeds. That coupled with no decrease in harvested acreage of forages and grain and higher yield of alfalfa increased the on-farm inventory of feeds. This is reflected in the greater amount of nutrients retained on the farm. At the end of 1993, the on-farm inventory of N and P was 12 tons and 0.9 tons respectively. These nutrients are essentially in reserve and do not constitute any direct threat to the environment.

TABLE 8. ANNUAL NITROGEN AND PHOSPHORUS INPUTS, OUTPUTS AND BALANCES ON THE MINER INSTITUTE DAIRY FARM FOR 1992 AND 1993.

Unit	Nitrogen		Phosphorus	
	1992	1993	1992	1993
Inputs:	----- tons -----		----- tons -----	
Feed	9.49 (40) ^a	11.81 (45)	1.76 (49)	2.05 (54)
Fertilizer	8.00 (34)	7.04 (27)	1.74 (48)	1.67 (44)
Livestock	0.12 (.5)	0	0.03 (0.8)	0
Other	0	0	0.07 (1.8)	0.07 (2.0)
N-Fixation	5.99 (25)	7.59 (29)		
Sub-total	23.60	26.44	3.60	3.79
Outputs:				
Milk	4.28	4.23	0.69	0.68
Livestock	0.63	0.29	0.18	0.08
Crops	0.85	0.15	0.15	
Sub-total	5.76	4.52	1.02	0.76
Balance	17.84	21.96	2.58	3.03
	76%	83%	72%	80%

^aNumber in () represents % of sub-total.

Comparing the two farms, the N balances were similar at 86% on the Pennsylvania farm and 80% for Miner Institute, two year average. However, the P-balance on the Pennsylvania farm was 53%, whereas, that of Miner Institute was 76%. On the surface it would appear that the Pennsylvania farm has a better management system for P. However, this may more accurately reflect differences between soil fertility levels than differences between farming systems.

The nutrient balance for the seven farms is presented in Table 9. This is a whole farm balance, only considering those materials purchased or sold. Manure and crops produced and utilized on the farm are not considered. Additionally, since all the farms were in a steady state, neither reducing or expanding, farm inventories were considered to be static.

Purchased feed and bedding made significant contributions to the total N and P inputs, 74% and 67%, respectively. The same parameters for the Pennsylvania dairy farm were 60% of the N inputs and 63% of the P inputs as livestock feed and bedding. In contrast, the farms in the St. Esprit Watershed study that were dairy oriented averaged 9% of the total P inputs as livestock feed and bedding.

On the Pennsylvania dairy farm 53% of the purchased P remained on the farm. The average for the seven farms in the Basin was 68%. Again this difference reflects the region's inability to produce sufficient grain to support the dairy farms. The important question is which is best, the 53% P retained or the 68% P retained. We would suggest that given the large differences in management and environment between the two regions, a direct comparison is incorrect.

TABLE 9. TOTAL INPUT, OUTPUT AND BALANCE FOR N,P, AND K.

	N	P	K
Total	----- tons, DM basis -----		
Inputs	116	27	64
Outputs	53	9	14
NET on Farm	63	19	50
% of Inputs	54.3%	70.4%	78.1%
Inputs			
Feed/Bedding	85	18	24
Fertilizer	30	9	40
Livestock	1		
Outputs			
Livestock	3	1	0
Milk	46	7	12
Crops	4	1	2

If comparisons are difficult to make between regions, can we compare farms within a region? Individual nutrient balances for the seven participating farms are found in the appendices. These farms represented a cross-section of dairy and farm management strategies. The differences are reflected in the variation among the nutrient balances.

Table 10 shows the P balance for each of the seven farms corrected for cropland acreage (lb P/acre of cropland). The percentage of purchased P retained per acre ranged from 40.1% to 75.5%. Given that degree of variability, based on this study 68% of the farms in the basin would have a P retention of between 53% and 73%.

The average net P loading (lb P retained per acre) for all the farms participating in the study was 18 lbs/A. This figure does not compare well with the loading observed on the farm in Pennsylvania, 8.2 lb/A. This difference of nearly 10 lb P is due primarily to management and environmental differences between the two regions. Farms in the Mid-Atlantic region have the ability to produce much of the grain required on the farm. Grain production in our region is limited and much of the grain fed to our livestock is imported. This difference becomes evident if we look at feed and bedding P imports per cow. On a per cow basis, farms in the Champlain Basin purchased 32 lb P per year. The Pennsylvania farm purchased only 10.4 lb P per cow each year, a difference of 207%.

In terms of the individual farms, Farm-23 had the lowest P retention (40.1%), however, this farm purchased no fertilizer P in 1995, which was unusual. The reason given was an economic one, and under normal circumstances fertilizer P would have been purchased. The second lowest P retention (52.1%) was that of the hill-farm which grows no corn and uses pasture.

TABLE 10. PHOSPHORUS IMPORTS AND EXPORTS PER ACRE OF CROPLAND AND BALANCE FOR SEVEN FARMS LOCATED IN THE LAKE CHAMPLAIN BASIN

Code	New York Farms			Vermont Farms				Mean
	11	12	21	22	23	24	25	
	----- lb P / A Cropland -----							
Inputs	21	55	30	17	10	37	20	27.14
Outputs	6	15	12	8	6	9	7	9
Net	15	40	18	9	4	28	13	18.14
% Total	71.2	72.0	62.3	52.1	40.1	75.5	67.8	63
Inputs								
Feed	15	44	24	17	10	14	2	18
Fertilizer	5	11	6	-	-	23	18	9
Stock	1	-	-	-	-	-	-	.14
Outputs								
Stock	1	1	1	1	-	1	1	1
Milk	4	14	11	7	6	8	3	7.57
Crops	1	-	-	-	-	-	3	0.57

The highest P retention was that on Farm-24 located in an area of low inherent soil fertility and poor drainage. These characteristics delay planting dates, increase fertilizer requirement, and reduce yields. These factors combine to increase inputs and decrease outputs resulting in increased P retention.

Summary

What is the fate of nutrients brought on to the farm? Is the phosphorus retained a potential pollutant? What represents an "acceptable" mass balance?

Nutrients arrive on farms in a variety of ways and forms. On a dairy farm these nutrients arrived predominantly as purchased feeds. Increasing production of legumes on the farm will reduce off-farm purchases of protein feeds and nitrogen fertilizers. Application of manure to legume stands to supply P can also reduce farm purchases of P fertilizer.

Nitrogen and P not sold does not necessarily become a pollutant. As we have seen, most of the N and P end up in either the milk or manure. However, if the animal inventory on the farm is growing then some of these remaining nutrients will be sequestered in animal tissue. Depending on the environment, a portion of the nitrogen in the urine can be volatilized and lost as ammonia gas (VanHorn et. al., 1991). Also, depending on the equilibrium state of the farm, N and P can be found in storage on the farm in the form of feeds if feed production or purchases temporarily exceed animal

needs. In addition, bulk purchases of bedding materials or fertilizers may have a similar impact.

What is acceptable? A mass balance is essentially a measure of inefficiency, therefore, it can only be as good as the least efficient unit in the system. In the case of the dairy farm we are restricted by the cow's efficiency in converting nutrients into milk. The inefficiency of P use ranges from 69% to 80% (Morse et. al., 1992). On dairy farms mass balances lower than these figures are attainable by selling crops as well as milk.

Mass balances of nutrients in agricultural systems can provide powerful tools to ascertain trends in nutrient use and provide mechanisms by which management changes may affect environmental impact. Whole farm nutrient balances can provide an overall view of the system balance and yearly trends, but only offer limited information on the dynamics of nutrient use within the specific units within the farm. Accurate use requires not only estimates of mass balance but current and past management, farm status, and information regarding the source of the information used to obtain reliable and useful estimates.

This study is a "snap-shot" of the situation on seven farms in 1995. Studies conducted at Miner Institute indicate that management changes can significantly impact the net flux of nutrients in a given year. The net flux of phosphorus on any given dairy farm is a function of animal density and the level of milk production.

Use of farm records was essential in obtaining the data necessary for a nutrient management assessment. Those farms which were active members of a crop management association or that worked closely with a crop management advisor had very detailed records for individual fields and crops. In general these farms had lower crop P balances than those farms which did not use professional services.

Animal number and density appeared to play a significant role in the flow of P across the farm gate. Nutrient imports specifically for the dairy averaged 67% of total import P. This process of nutrient retention on the farm from external sources to support the livestock illustrates the problems associated with reducing nutrient retention on intensive livestock operations.

Recommendations

Best management practices for improving the P balance on Champlain Basin dairy farms.

1. Consider current and future animal density before expanding the dairy operation. Most dairy farms in the Champlain Basin which have less than two acres per lactating cow find a reasonable P balance very difficult to achieve. It may be necessary to buy or rent additional cropland, not only to provide sufficient forage but to have enough land for proper manure utilization.
2. Maximize the use of manure as a fertilizer, including topdressing on alfalfa and other legume fields. The application of P fertilizer to established alfalfa can in most cases be eliminated by manure application immediately following legume harvest.

3. Soil test regularly and follow a responsible soil fertility program. The reliability of most soil analyses is excellent; if the soil test reports available P to be high, there will be little or no response to added P. There is research data showing that when soil P levels are very high, crop yields are actually reduced by the application of moderate rates of fertilizer P. In this situation, P additions are increased and P removal is reduced.
4. If economics permit, consider changing daily spread operations to slurry or liquid manure handling. This permits storage of manure until the ideal time of application, and liquid manure spreaders do a more uniform job of spreading manure.
5. If economics do not permit a change to liquid manure, build a semi-solid storage which will retain both solid and liquid waste so that winter application is unnecessary.
6. If animal density is high and it is not feasible to acquire additional cropland, consider marketing manure off the farm as compost or to farm operations which do not have livestock. Timely application of manure to forest land is sometimes a better alternative than applying high rates of manure on land which already has excessive levels of P and other nutrients.
7. Become a member of a crop management association or enlist the assistance of a crop consultant. The services provided will better enable a farm operator to better manage the farm by better management of the individual fields.
8. Minimize P levels in the livestock ration. Feed the animals in uniform groups and tailor their feed to more exactly meet the animal's requirements.
9. Have the feed ingredients tested frequently. To adequately balance rations to meet the needs of the animal you must know what is in it. Labeling laws only require that the minimum level of P be listed.

References

- Beaman, T. T. 1992. Design and initial implementation of a comprehensive agricultural monitoring and evaluation network for the Lake Champlain Basin. NY-VT Strategic Core Group. February 1993. Lake Champlain Basin Program Technical Report No. 2. U.S. Environmental Protection Agency, Boston, MA. 77 pp.
- Frink, C.R. 1969. Water pollution potential estimated from farm nutrient budgets. *Agron. J.* 51:550.
- Klausner, S.D. 1992. Nutrient management on livestock farms. Cornell University Dept. of Soil, Crop, and Atmospheric Sciences Extension Series No. E92-4.
- Lake Champlain Management Conference. Pollution Prevention, Control, and Restoration Plan Draft Document, January 1993.
- Lanyon, L. E. and D. B. Beegle. 1989. The role of on-farm nutrient balance assessments in an integrated approach to nutrient management. *J. Soil and Water Cons.* 44:164-168.
- Lanyon, L. E. and D. B. Beegle. 1993. Nutrient Management. *Agronomy Facts* 16. Penn State Cooperative Extension. University Park, PA.
- Lanyon, L.E. 1992. Implications of dairy herd size for farm material transport, plant nutrient management, and water quality. *J. Dairy Sci.* 75:334.
- McCollum, R.E. 1991. Buildup and decline of soil phosphorus: 30-year trends on a Typic Umprabult. *Agron. J.* 83:77-85.
- Morse, D., H.H. Head, C. J. Wilcox, H. H. VanHorn, C. D. Hissem and B. Harris Jr. 1992. Effects of concentration of dietary phosphorus on amount and route of excretion. *J. Dairy Sci.* 75:1979.
- National Research Council. 1993. Nutrient requirements of dairy cattle. 6th rev. ed. Natl. Acad. Press. Washington, D.C.
- National Research Council. 1993. Soil and Water Quality - An agenda for agriculture. Committee on Long-Range Soil and Water Conservation. Natl. Acad. Press. Washington, D.C.

- New York State Department of Agriculture and Markets. N.Y. State Dairy Statistics, 1992 Annual Summary.
- Northeast Dairy Herd Improvement Cooperative. Clinton County herd listings, May, 1994.
- Ontario Farm Association. 1994. Ontario Environmental Farm Plan Workbook. Ontario Federation of Agriculture. Toronto, Ont.
- Pennsylvania Department of Environmental Resources. Pennsylvania's Chesapeake Bay Nutrient Reduction Strategy, Interim Report September 10, 1993.
- Sharpley, A. N., S.C. Chapra, R. Wedepohl, J.T. Sims, T. C. Daniel, and K.R. Reddy. 1994. Managing Agricultural Phosphorus for protection of surface waters: Issues and Options. J. Environ. Qual. 23:437-451.
- Sharpley, A. N., T. C. Daniel, and D. R. Edwards. 1993. Phosphorus movement in the landscape. J. Prod. Agric. 6:492-500.
- Tamminga, S. 1992. Nutrition management of dairy cows as a contribution for pollution potential. J. Dairy Sci., 75:345.
- Thomas, E.D. 1985. Nutrient Cycling Research at Miner Institute. Miner Institute. Chazy, NY.
- USDA. 1974 Census of Agriculture, Clinton County, N.Y.
- USDA/SCS. 1985b. Lower Winooski Watershed Plan, Vermont.
- USDA/SCS. 1983. Agricultural Runoff in Selected Vermont Watersheds.
- USDA/SCS. 1985a. Lemon Fair River Watershed Plan-EA, Vermont.

Individual farm evaluations

Farm-11--Animal units per crop acre are low, so there should be adequate cropland for manure spreading. Fertilizer P application rates are low, and fertilizer is only applied to the corn crop. The crop P balance is a relatively low +11%, indicating that as long as animal units and fertilizer rates are not increased, excess P should not become a problem.

Farm # 12--Animal units per crop acre are high, and fertilizer P rates are moderate. The corn crop receives almost 100# of P_2O_5 /acre plus a modest rate of starter P. The crop P balance is very high at +92%. Yearly soil test on all fields to be planted to corn may indicate reduced need for fertilizer P. If soil test P levels are high, the starter rate could be reduced from 30#/A of P_2O_5 to 20#. Manure is daily spread, and half of the cropland is well to excessively-well drained. Nitrogen leaching is highly likely on these soils; a manure storage structure would reduced leaching losses and allow more timely application of manure. Manure should be applied to alfalfa fields, especially those in the second year and later of production. Manure can also be substituted for commercial fertilizer prior to seeding alfalfa. If additional cropland is not obtained, serious consideration should be given to selling or otherwise moving manure off the farm.

Farm # 21--Animal units per crop acre are high, but fertilizer P use is low, crop yields are high, and the crop P balance is excellent at +1%. Continued emphasis should be placed on replacing fertilizer P with the phosphorus contained in manure. Although starter fertilizer P rates for corn are moderately low, regular soil testing should be used to monitor soil P levels, and where possible starter P rates reduced to 20# per acre of P_2O_5 .

Farm # 22--Animal units per crop acre are low, and no fertilizer P was used. This farm is the only one of the seven which has a crop P balance which is in deficit. Soil analysis should be used to monitor soil P levels, and recommended rates of fertilizer used. However, since this farm is in all grass, most or all of the P needs may be able to be met by a well-planned manure application schedule.

Farm # 23--Animal units per crop acre are low, and no fertilizer P is used. Crop removal of P is also low, however, and the crop P balance is only fair at +27%. Pollution potential is reduced by flat fields and over 60% of the cropland currently being in grass. Soil analysis should be used to monitor soil fertility; it is possible that at modest amount of fertilizer P will be needed on corn fields. Manure applied at rates sufficient to supply all of the nitrogen needed for the corn should eventually result in high soil P levels which would reduce the need for P fertilizer.

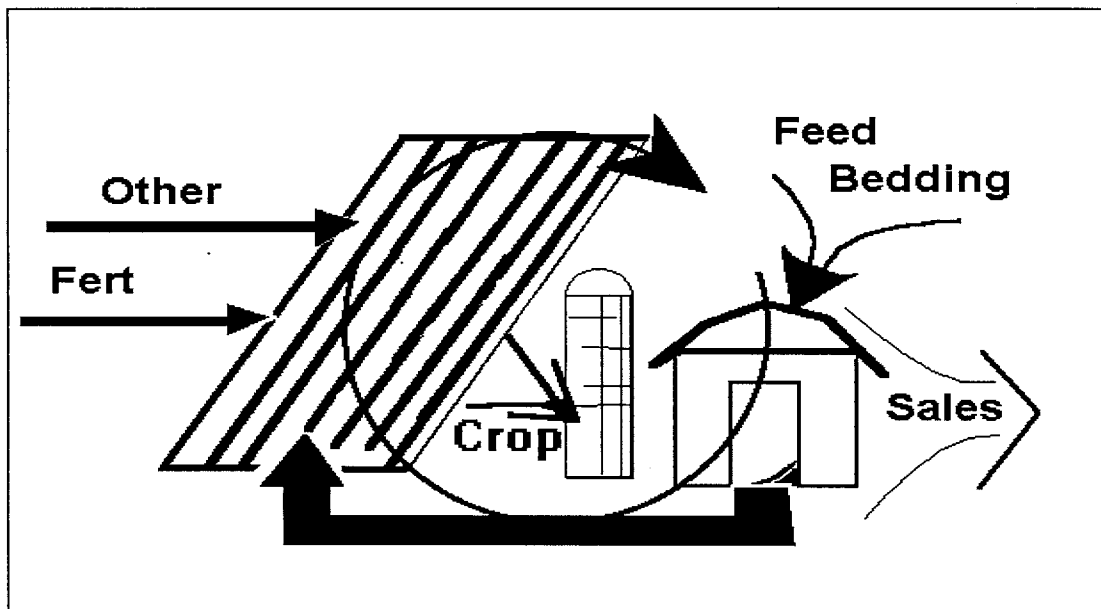
Farm # 24--Animal units per crop acre are very high, and should be a source of concern. The crop P balance is also high at +46%. In spite of the high animal units, 60# of P_2O_5 is used for corn production. Soil analysis should be used to confirm soil P levels, and if they are high, the fertilizer P rate should be reduced by 2/3. If soil P levels are very high,

reducing starter fertilizer P could actually result in yield increases since high soil P levels can adversely affect uptake of zinc, a commonly deficient micronutrient in corn production. A modest rate of fertilizer P is used on grass land; this could be replaced by topdressed manure as long as high soil K levels do not pose a problem. Consideration should be given to transporting excess manure off the farm.

Farm #25--Animal units per crop acre are low, and the crop P balance is good at +14%. Fertilizer P application rates are moderate. The crop P balance may be further improved by relying on soil analysis for P fertilizer recommendations; on corn fields with high soil P levels, the fertilizer P rate could be reduced by about 50%.

Appendices

Characterization Of On-Farm Phosphorus Budgets And Management In The Lake Champlain Basin



Adapted from Lanyon and Beegle, 1993

APPENDIX

TABLE A-1. NUTRIENT INPUTS, OUTPUTS, AND BALANCE FOR SEVEN FARMS REPRESENTING 1,875 ACRES AND 928 COWS LOCATED IN THE LAKE CHAMPLAIN BASIN IN 1995.	34
TABLE A-2. NUTRIENT INPUTS, OUTPUTS, AND BALANCE FOR FARM-11, 378 ACRES AND 95 COWS.....	35
TABLE A-3. NUTRIENT INPUTS, OUTPUTS, AND BALANCE FOR FARM-12, 321 ACRES AND 253 COWS.....	36
TABLE A-4. NUTRIENT INPUTS, OUTPUTS, AND BALANCE FOR FARM-21 377 ACRES AND 250 COWS.....	37
TABLE A-5. NUTRIENT INPUTS, OUTPUTS, AND BALANCE FOR FARM-22, 131 ACRES AND 95 COWS.....	38
TABLE A-6. NUTRIENT INPUTS, OUTPUTS, AND BALANCE FOR FARM-23, 173 ACRES AND 80 COWS.....	39
TABLE A-7. NUTRIENT INPUTS, OUTPUTS, AND BALANCE FOR FARM-24, 217 ACRES AND 120 COWS.....	40
TABLE A-8. NUTRIENT INPUTS, OUTPUTS, AND BALANCE FOR FARM-25, 278 ACRES AND 85 COWS.....	41
FIGURE A-1. DISTRIBUTION OF SOIL TEXTURE ON FARM-11.	42
FIGURE A-2. DISTRIBUTION OF SOIL TEXTURE ON FARM-12.	43
FIGURE A-3. DISTRIBUTION OF SOIL TEXTURE ON FARM-21.	44
FIGURE A-4. DISTRIBUTION OF SOIL TEXTURE ON FARM-22.	45
FIGURE A-5. DISTRIBUTION OF SOIL TEXTURE ON FARM-23.	46
FIGURE A-6. DISTRIBUTION OF SOIL TEXTURE ON FARM-24.	47
FIGURE A-7. DISTRIBUTION OF SOIL TEXTURE ON FARM-25.	48
FIGURE A-8. DISTRIBUTION OF SOIL DRAINAGE ON FARM-11.	49
FIGURE A-9. DISTRIBUTION OF SOIL DRAINAGE ON FARM-12.	50
FIGURE A-10. DISTRIBUTION OF SOIL DRAINAGE ON FARM-21.	51
FIGURE A-11. DISTRIBUTION OF SOIL DRAINAGE ON FARM-22.	52
FIGURE A-12. DISTRIBUTION OF SOIL DRAINAGE ON FARM-23.	53
FIGURE A-13. DISTRIBUTION OF SOIL DRAINAGE ON FARM-24.	54
FIGURE A-14. DISTRIBUTION OF SOIL DRAINAGE ON FARM-25.	55
FIGURE A-15. DISTRIBUTION OF SOIL SLOPE ON FARM-11.	56
FIGURE A-16. DISTRIBUTION OF SOIL SLOPE ON FARM-12.	57
FIGURE A-17. DISTRIBUTION OF SOIL SLOPE ON FARM-21.	58
FIGURE A-18. DISTRIBUTION OF SOIL SLOPE ON FARM-22.	59
FIGURE A-19. DISTRIBUTION OF SOIL SLOPE ON FARM-23.	60
FIGURE A-20. DISTRIBUTION OF SOIL SLOPE ON FARM-24.	61

FIGURE A-21. DISTRIBUTION OF SOIL SLOPE ON FARM-25.....	62
FIGURE A-22. CROP DISTRIBUTION ON FARM-11.....	63
FIGURE A-23. CROP DISTRIBUTION ON FARM-12.....	64
FIGURE A-24. CROP DISTRIBUTION ON FARM-21.....	65
FIGURE A-25. CROP DISTRIBUTION ON FARM-22.....	66
FIGURE A-26. CROP DISTRIBUTION ON FARM-23.....	67
FIGURE A-27. CROP DISTRIBUTION ON FARM-24.....	68
FIGURE A-28. CROP DISTRIBUTION ON FARM-25.....	69
FIGURE A-29. OVERALL CROP DISTRIBUTION FOR SEVEN FARMS IN THE LAKE CHAMPLAIN BASIN.	70
FIGURE A-30. TOTAL P_2O_5 USE ON CROPLAND.	71
FIGURE A-31. P_2O_5 USE ON LEGUMES AND LEGUME/GRASS MIXES.	72
FIGURE A-32. P_2O_5 USE ON CORN.....	73
FIGURE A-33. P_2O_5 USE ON GRASS.....	74
FIGURE A-34. P_2O_5 USE ON OTHER CROPS.....	75
FIGURE A-35. DISTRIBUTION OF P_2O_5 FROM MANURE BY CROP AND SEASON FOR SEVEN FARMS IN THE LAKE CHAMPLAIN BASIN.	76
FIGURE A-36. DISTRIBUTION OF P_2O_5 FROM CHEMICAL FERTILIZER BY CROP AND SEASON FOR SEVEN FARMS IN THE LAKE CHAMPLAIN BASIN.....	77
FIGURE A-37. SEASONAL DISTRIBUTION OF P_2O_5 APPLICATIONS ON FARM-11.....	78
FIGURE A-38. SEASONAL DISTRIBUTION OF P_2O_5 APPLICATIONS ON FARM-12.....	79
FIGURE A-39. SEASONAL DISTRIBUTION OF P_2O_5 APPLICATIONS ON FARM-21.....	80
FIGURE A-40. SEASONAL DISTRIBUTION OF P_2O_5 APPLICATIONS ON FARM-22.....	81
FIGURE A-41. SEASONAL DISTRIBUTION OF P_2O_5 APPLICATIONS ON FARM-23.....	82
FIGURE A-43. SEASONAL DISTRIBUTION OF P_2O_5 APPLICATIONS ON FARM-24.....	83
FIGURE A-43. SEASONAL DISTRIBUTION OF P_2O_5 APPLICATIONS ON FARM-25.....	84
TABLE A-9. FIELD INFORMATION FOR THE SEVEN FARMS IN THE ON-FARM PHOSPHORUS STUDY.....	88
TABLE A-10. FERTILIZER INFORMATION FOR THE SEVEN FARMS IN THE ON-FARM PHOSPHORUS STUDY	93

TABLE A-11 PLANTING INFORMATION FOR THE SEVEN FARMS IN THE ON-FARM PHOSPHORUS STUDY	100
TABLE A-12. HARVEST INFORMATION FOR THE SEVEN FARMS IN THE ON-FARM PHOSPHORUS STUDY	103

**TABLE A-1. NUTRIENT INPUTS, OUTPUTS, AND
BALANCE FOR SEVEN FARMS
REPRESENTING 1,875 ACRES AND 928
COWS LOCATED IN THE LAKE
CHAMPLAIN BASIN IN 1995.**

	Nit	Phos	Potas
	----- lb -----		
Total Inputs	230,940	54,637	126,580
Outputs	107,207	17,400	29,494
Net	123,734	37,238	97,087
Percent On Farm	53.58%	68.15%	76.70%
Inputs:			
Purchased Feed/Bedding	169,756	35,981	47,376
Crop Fertilizer	59,327	18,154	79,025
Stock Purchases	1,716	455	130
Outputs:			
Livestock Sales	5,950	1,608	450
Milk Sales	91,424	14,693	24,488
Crop Sale	8,479	1,099	4,555

Miner Institute, 1996

**TABLE A-2. NUTRIENT INPUTS, OUTPUTS, AND
BALANCE FOR FARM-11, 378 ACRES
AND 95 COWS.**

	Nit	Phos	Potas
	----- lb -----		
Total Inputs	37,266	7,933	23,647
Outputs	14,262	2,293	5,007
Net	23,004	5,640	18,640
Percent On Farm	61.7%	71.1%	78.8%
Inputs:			
Purchased Feed/Bedding	24,702	5,550	8,017
Crop Fertilizer	10,848	1,913	15,500
Stock Purchases.....	1,716	455	130
Dairy Supplies	0	15	0
Outputs:			
Livestock Sales....	1,934	483	148
Milk Sales	9,715	1,561	2,602
Crop Sale	2,613	249	2,257

Miner Institute, 1996

**TABLE A-3. NUTRIENT INPUTS, OUTPUTS, AND BALANCE
FOR FARM-12, 321 ACRES AND 253 COWS.**

	Nit	Phos	Potas
	----- lb -----		
Total Inputs	75,174	17,726	28,618
Outputs	30,305	4,962	7,796
Net	44,868	12,764	20,822
Percent On Farm	59.7%	72.0%	72.8%
Inputs:			
Purchased Feed/Bedding	68,680	14,048	20,418
Crop Fertilizer	6,494	3,678	8,200
Stock Purchases.....	0	0	0
Outputs:			
Livestock sales....	1,223	340	92
Milk sales.	28,762	4,622	7,704
Crop sale.....	0	0	0

Miner Institute, 1996

**TABLE A-4. NUTRIENT INPUTS, OUTPUTS, AND BALANCE
FOR FARM-21 377 ACRES AND 250 COWS.**

	Nit	Phos	Potas
	----- lb -----		
Total Inputs	63,047	11,401	36,402
Outputs	26,553	4,303	6,859
Net	36,493	7,098	29,543
Percent On Farm	57.9%	62.3%	81.2%
Inputs:			
Purchased Feed/Bedding	41,887	8,998	8,377
Crop Fertilizer	21,160	2,403	28,025
Stock Purchases.....	0	0	0
Outputs:			
Livestock Sales....	793	223	60
Milk Sales	25,384	4,080	6,799
Crop Sale	0	0	0

Miner Institute, 1996

**TABLE A-5. NUTRIENT INPUTS, OUTPUTS, AND BALANCE
FOR FARM-22, 131 ACRES AND 95 COWS.**

	Nit	Phos	Potas
	----- lb -----		
Total Inputs	13,613	2,184	7,723
Outputs	5,993	1,046	1,472
Net	7,620	1,138	6,251
Percent On Farm	56.0%	52.1%	80.9%
Inputs:			
Purchased Feed/Bedding	8,383	2,184	3,023
Crop Fertilizer	5,230	0	4,700
Stock Purchases.....	0	0	0
Outputs:			
Livestock Sales....	690	194	52
Milk Sales	5,303	852	1,420
Crop Sale	0	0	0

Miner Institute, 1996

**TABLE A-6. NUTRIENT INPUTS, OUTPUTS, AND BALANCE
FOR FARM-23, 173 ACRES AND 80 COWS.**

	Nit	Phos	Potas
	----- lb -----		
Total Inputs	15,667	1,696	8,935
Outputs	6,326	1,017	1,694
Net	9,342	679	7,241
Percent On Farm	59.6%	40.1%	81.0%
Inputs:			
Purchased Feed/Bedding	9,951	1,696	2,873
Crop Fertilizer	5,716	0	6,062
Stock Purchases.....	0	0	0
Outputs:			
Livestock Sales	0	0	0
Milk Sales	6,326	1,017	1,694
Crop Sale	0	0	0

Miner Institute, 1996

**TABLE A-7. NUTRIENT INPUTS, OUTPUTS, AND BALANCE
FOR FARM-24, 217 ACRES AND 120 COWS.**

	Nit	Phos	Potas
	----- lb -----		
Total Inputs	17,780	8,062	13,695
Outputs	11,685	1,976	2,973
Net	6,095	6,086	10,722
Percent On Farm	34.3%	75.5%	78.3%
Inputs:			
Purchased Feed/Bedding	12,946	2,963	4,125
Crop Fertilizer	4,834	5,099	9,570
Stock Purchases.....	0	0	0
Outputs:			
Livestock Sales	814	229	61
Milk Sales	10,871	1,747	2,912
Crop Sale	0	0	0

Miner Institute, 1996

**TABLE A-8. NUTRIENT INPUTS, OUTPUTS, AND BALANCE
FOR FARM-25, 278 ACRES AND 85 COWS.**

	Nit	Phos	Potas
	----- lb -----		
Total Inputs	8,252	5,603	7,510
Outputs	11,704	1,802	3,692
Net	(3,451)	3,801	3,818
Percent On Farm	-41.8%	67.8%	50.8%
Inputs:			
Purchased Feed/Bedding	3,207	542	542
Crop Fertilizer	5,045	5,061	6,968
Stock Purchases.....	0	0	0
Outputs:			
Livestock Sales	496	139	37
Milk Sales	5,063	814	1,356
Crop Sale	5,866	849	2,298

Miner Institute, 1996

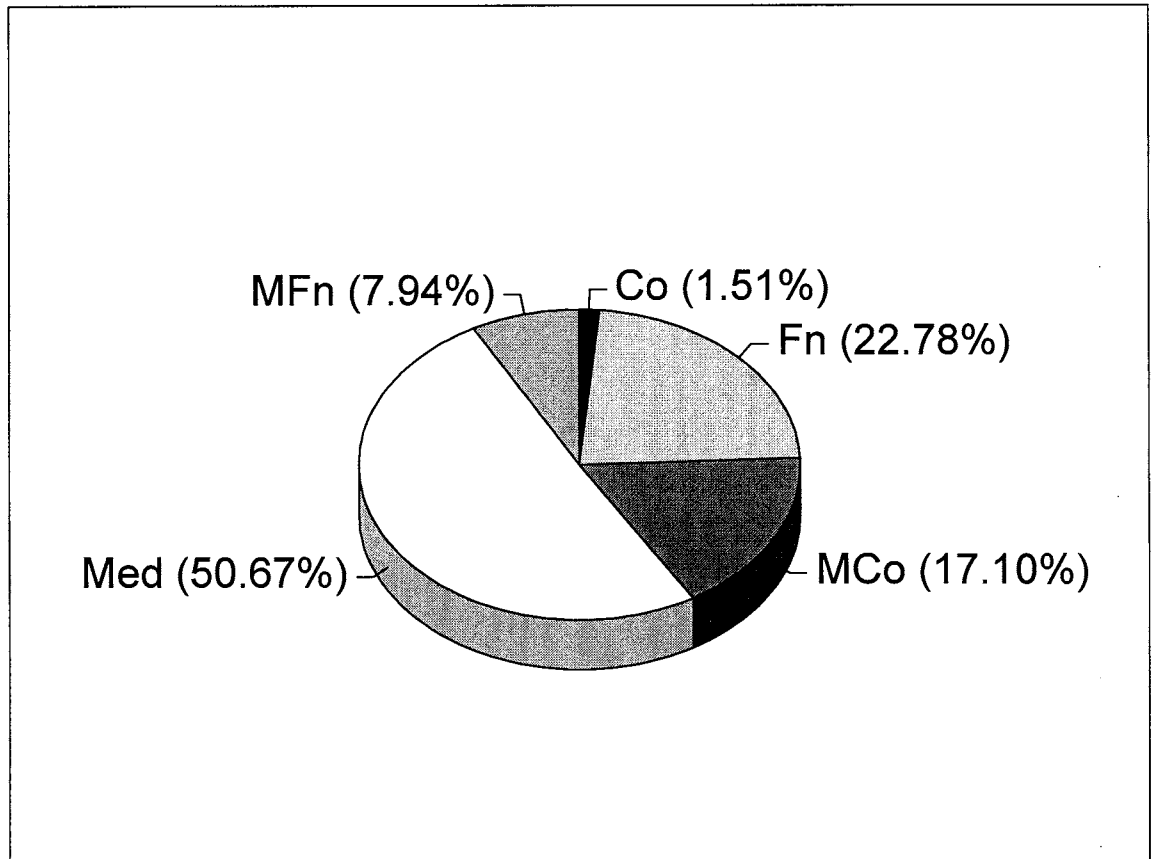


FIGURE A-1. DISTRIBUTION OF SOIL TEXTURE ON FARM-11.

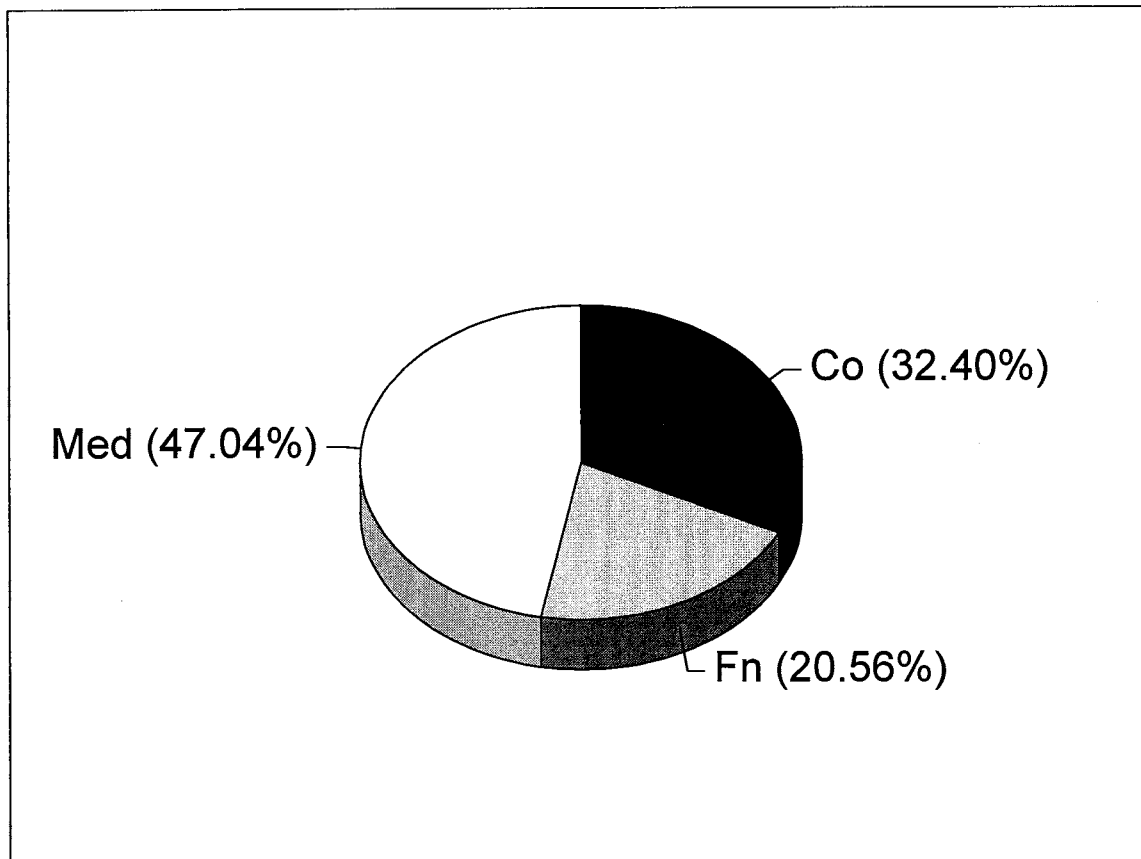


FIGURE A-2. DISTRIBUTION OF SOIL TEXTURE ON FARM-12

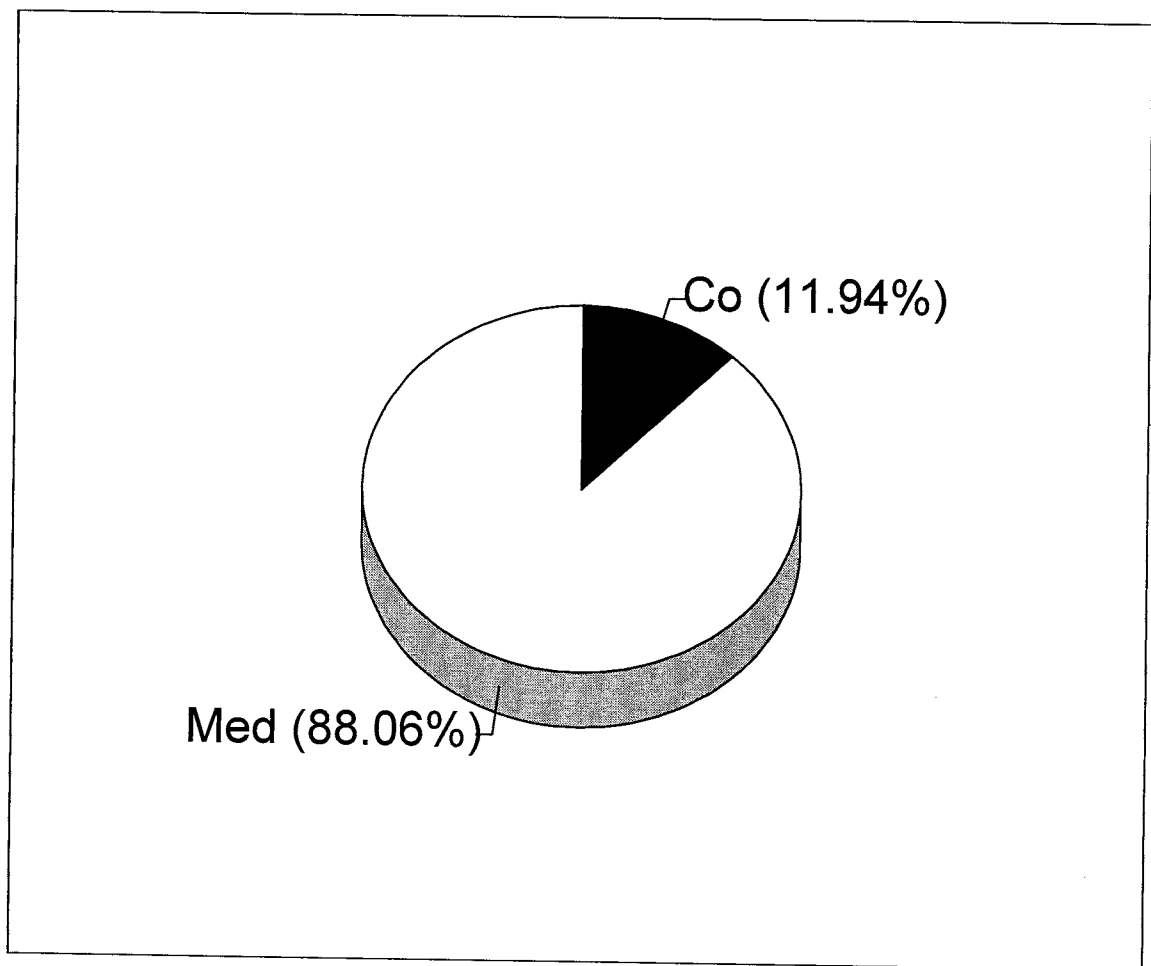


FIGURE A-3. DISTRIBUTION OF SOIL TEXTURE ON FARM-21

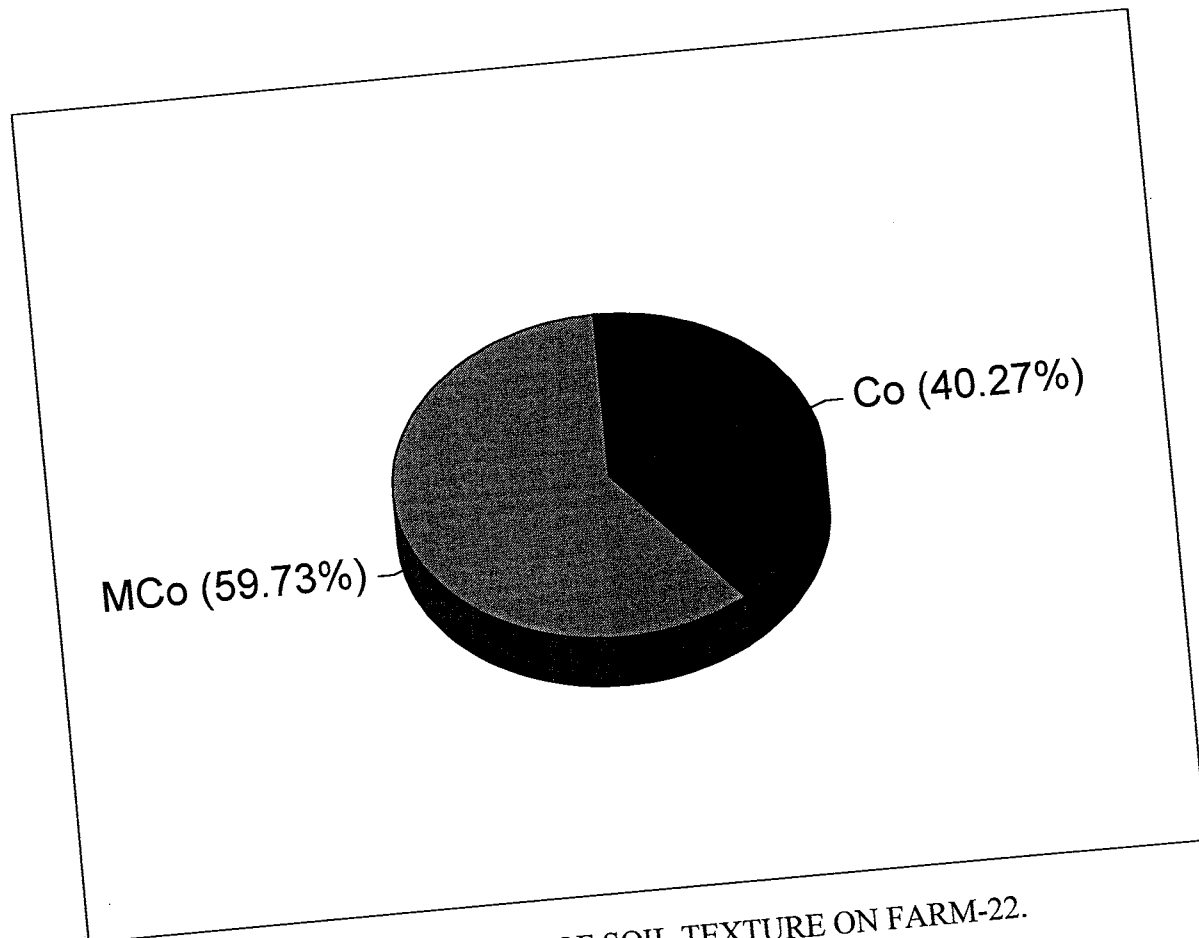


FIGURE A-4. DISTRIBUTION OF SOIL TEXTURE ON FARM-22.

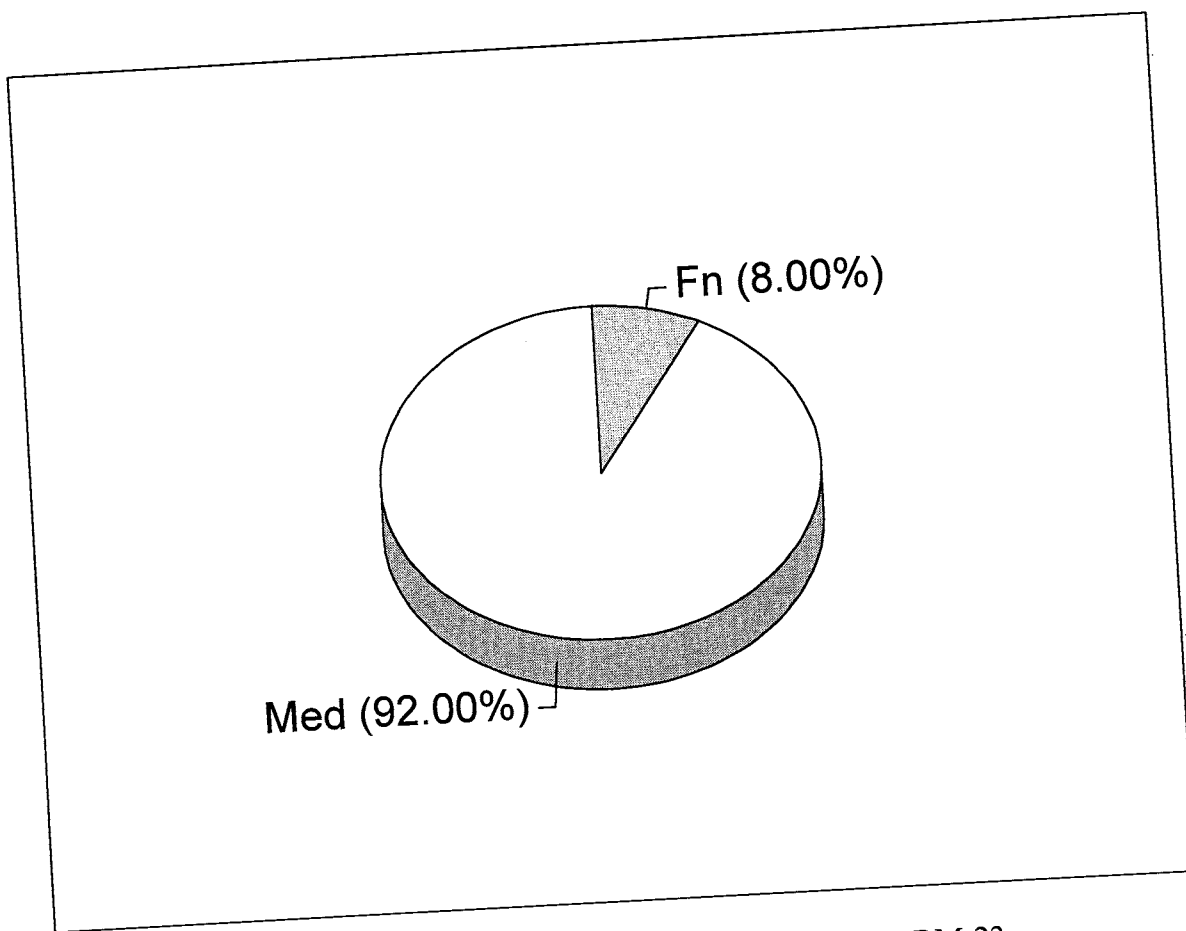


FIGURE A-5. DISTRIBUTION OF SOIL TEXTURE ON FARM-23.

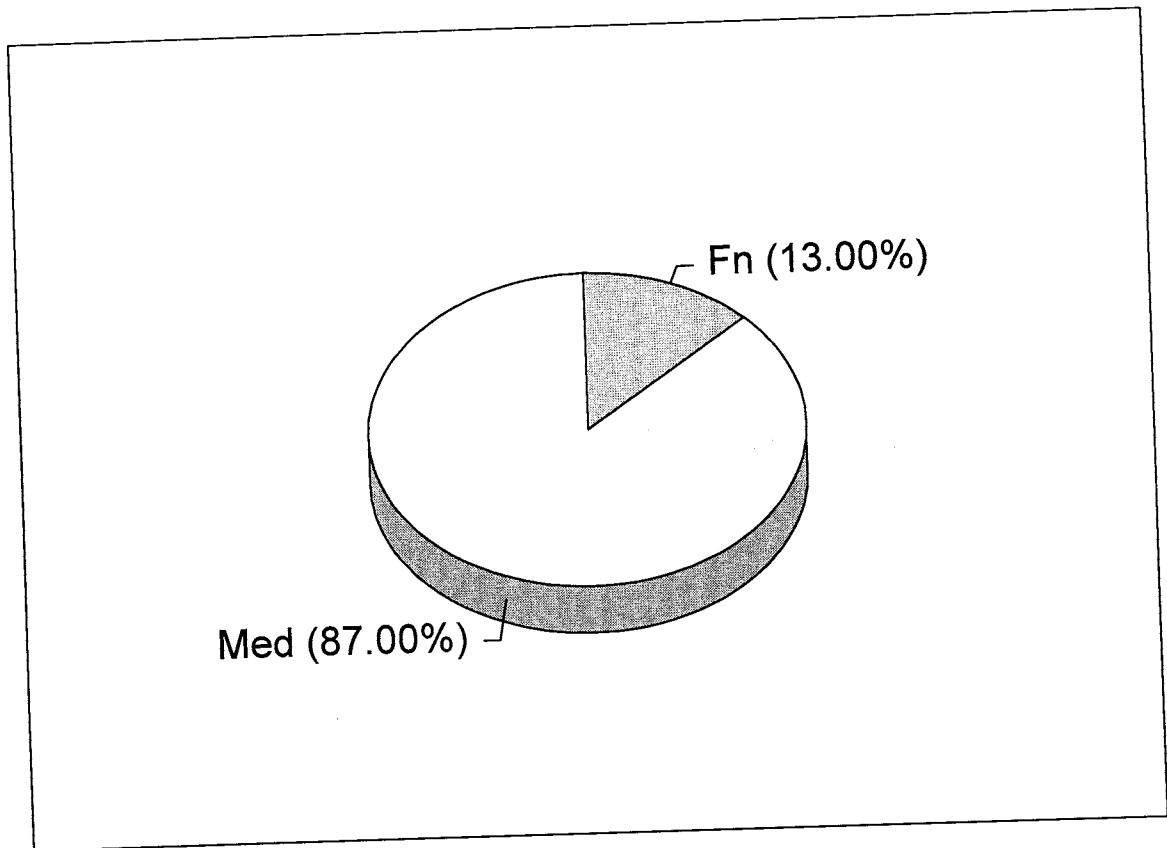


FIGURE A-6. DISTRIBUTION OF SOIL TEXTURE ON FARM-24.

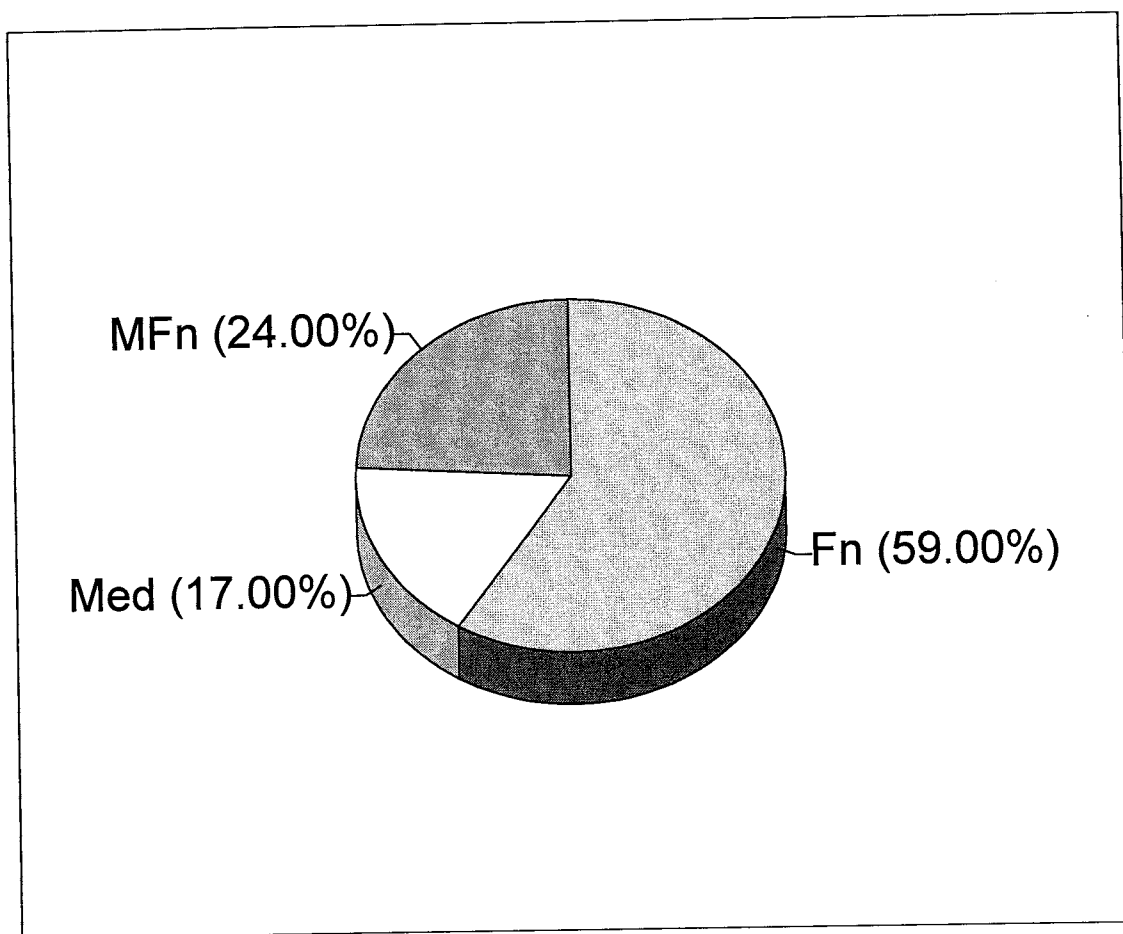


FIGURE A-7. DISTRIBUTION OF SOIL TEXTURE ON FARM-25.

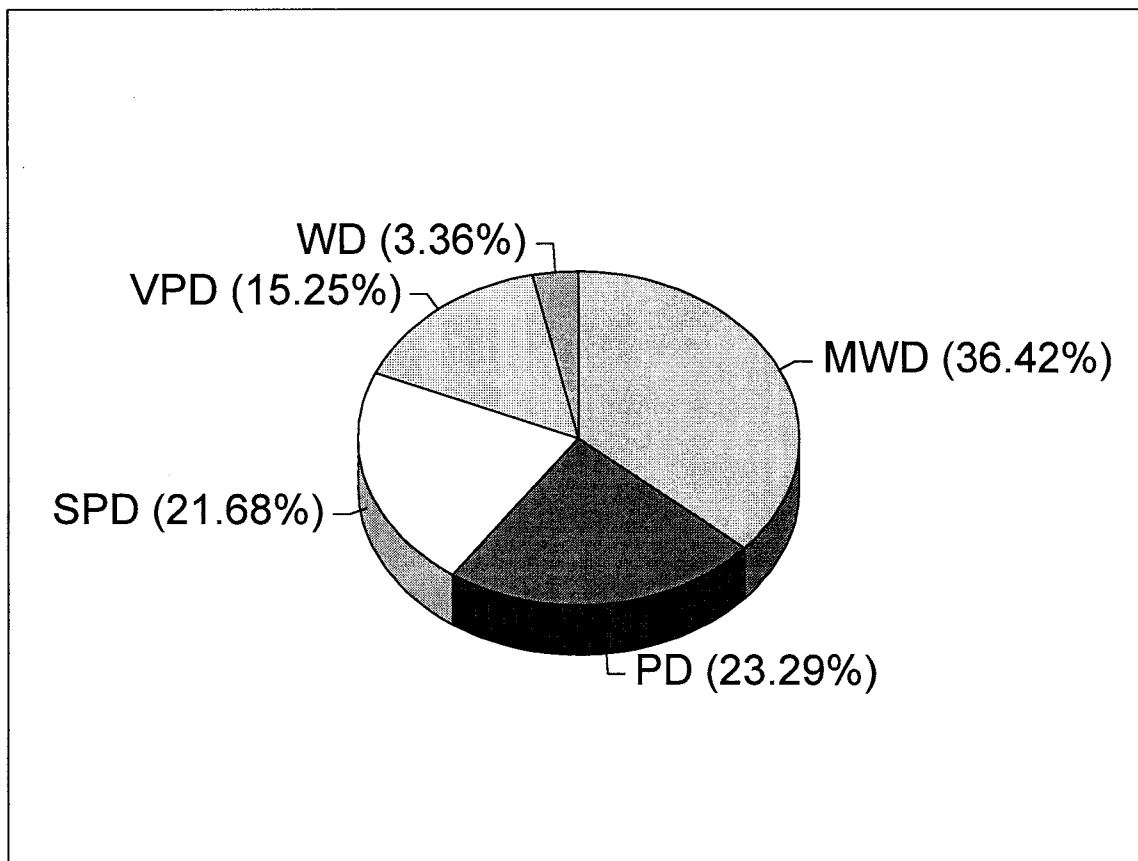


FIGURE A-8. DISTRIBUTION OF SOIL DRAINAGE ON FARM-11.

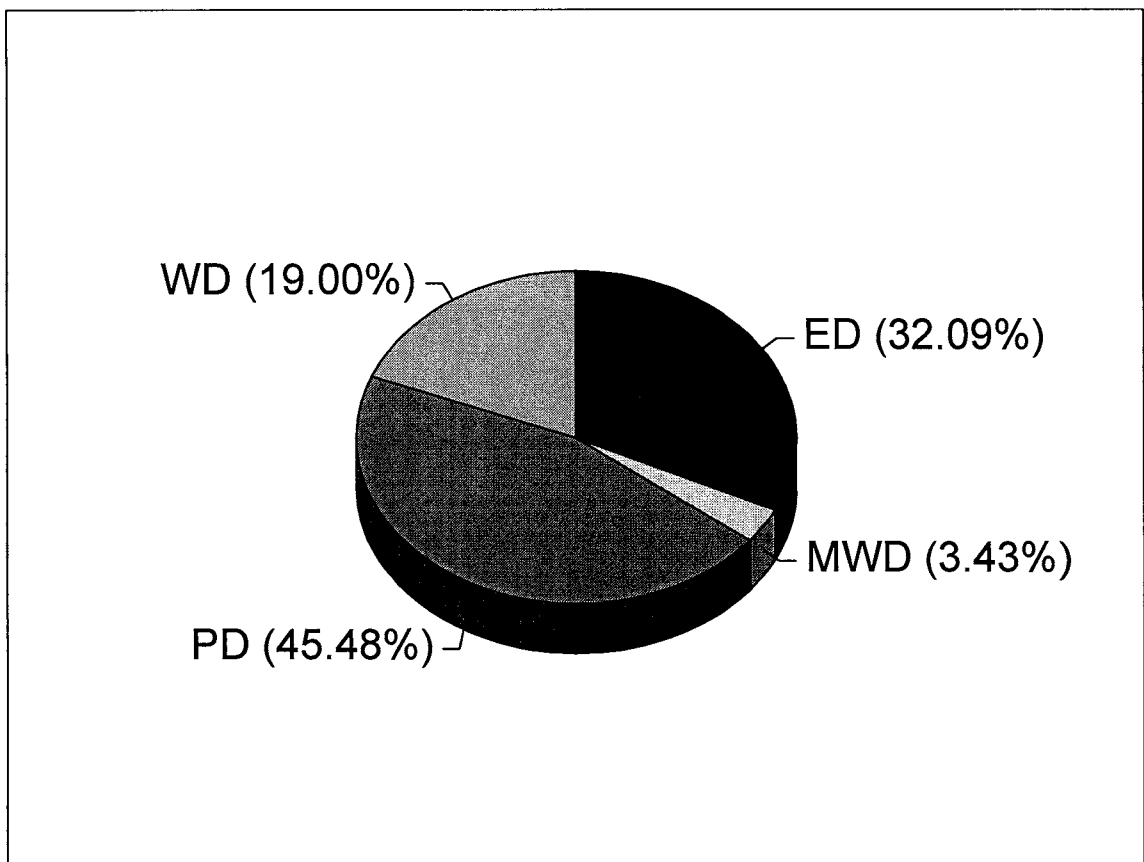


FIGURE A-9. DISTRIBUTION OF SOIL DRAINAGE ON FARM-12.

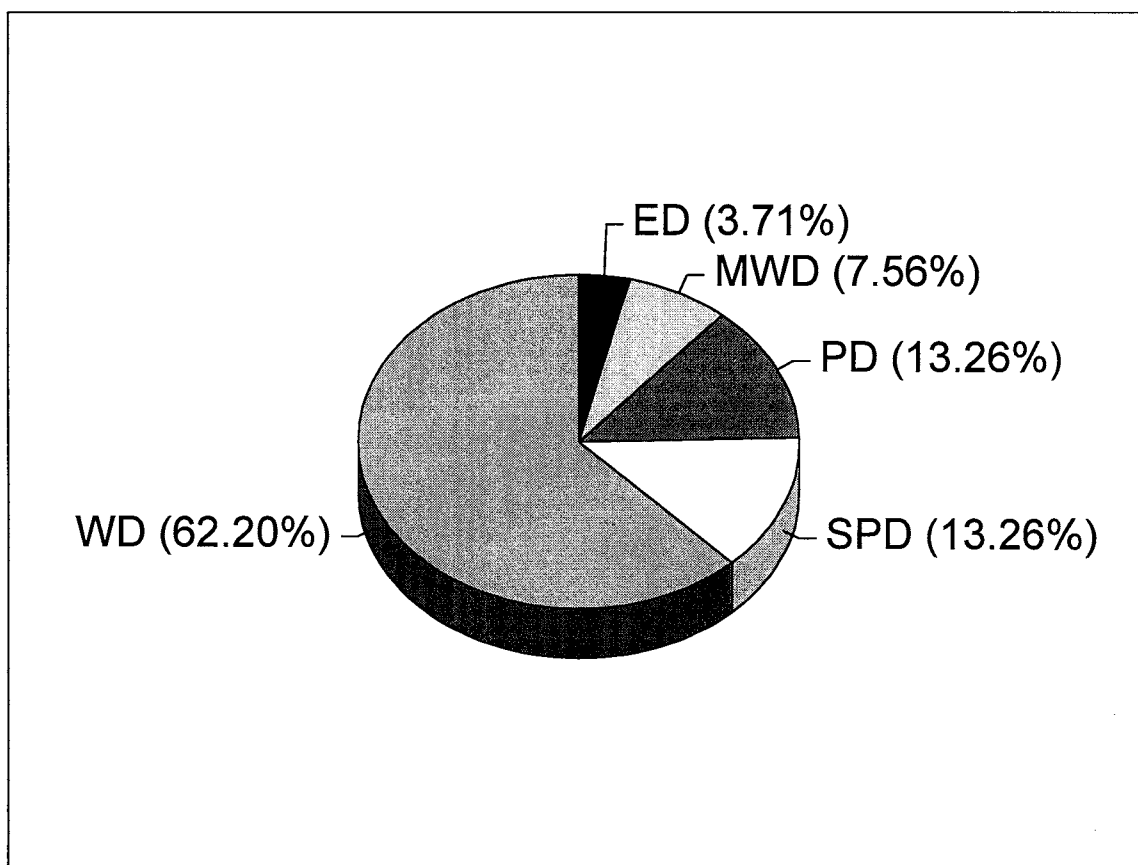


FIGURE A-10. DISTRIBUTION OF SOIL DRAINAGE ON FARM-21.

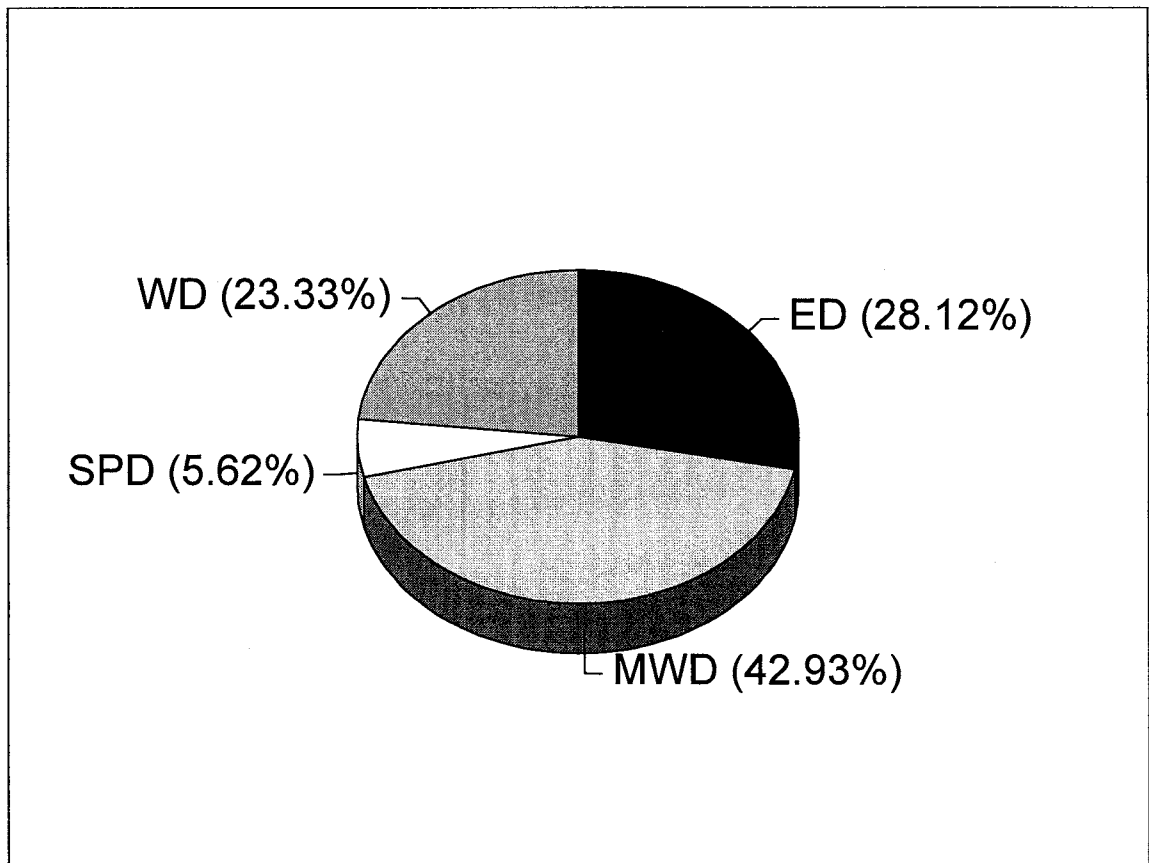


FIGURE A-11. DISTRIBUTION OF SOIL DRAINAGE ON FARM-22.

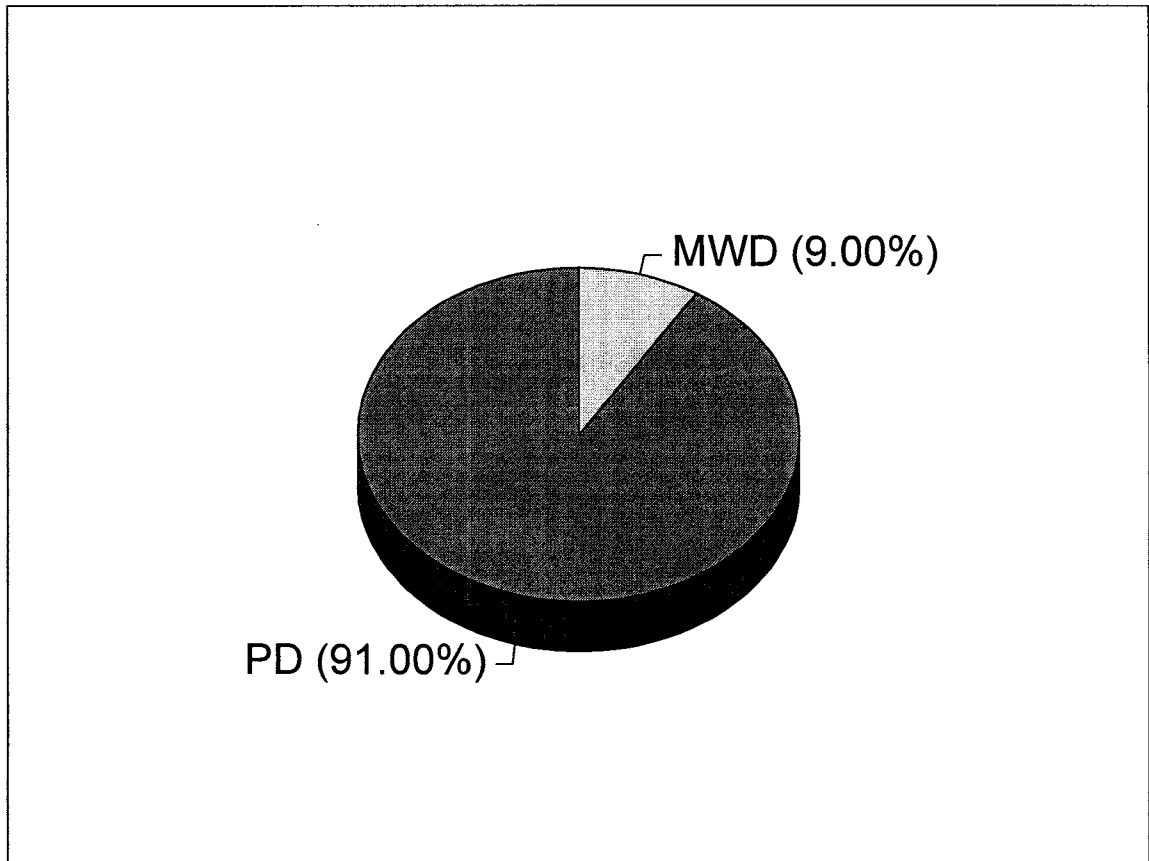


FIGURE A-12. DISTRIBUTION OF SOIL DRAINAGE ON FARM-23.

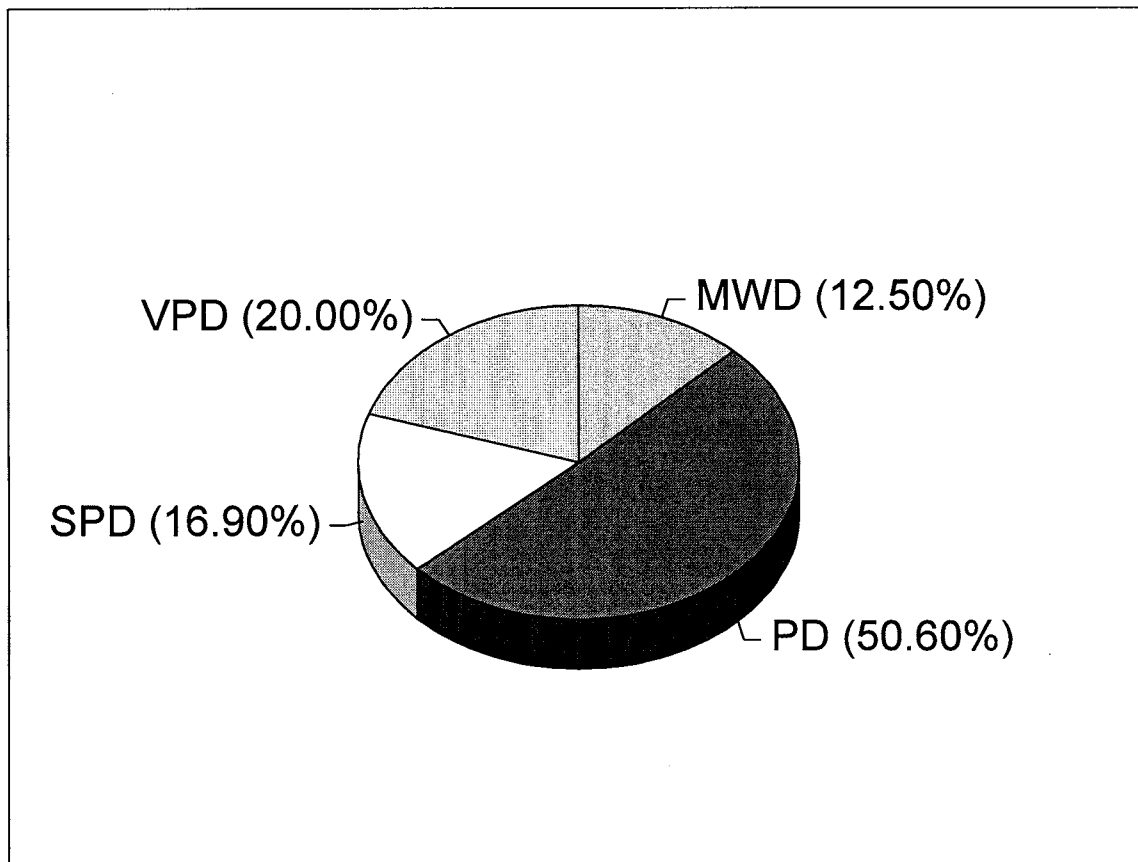


FIGURE A-13. DISTRIBUTION OF SOIL DRAINAGE ON FARM-24.

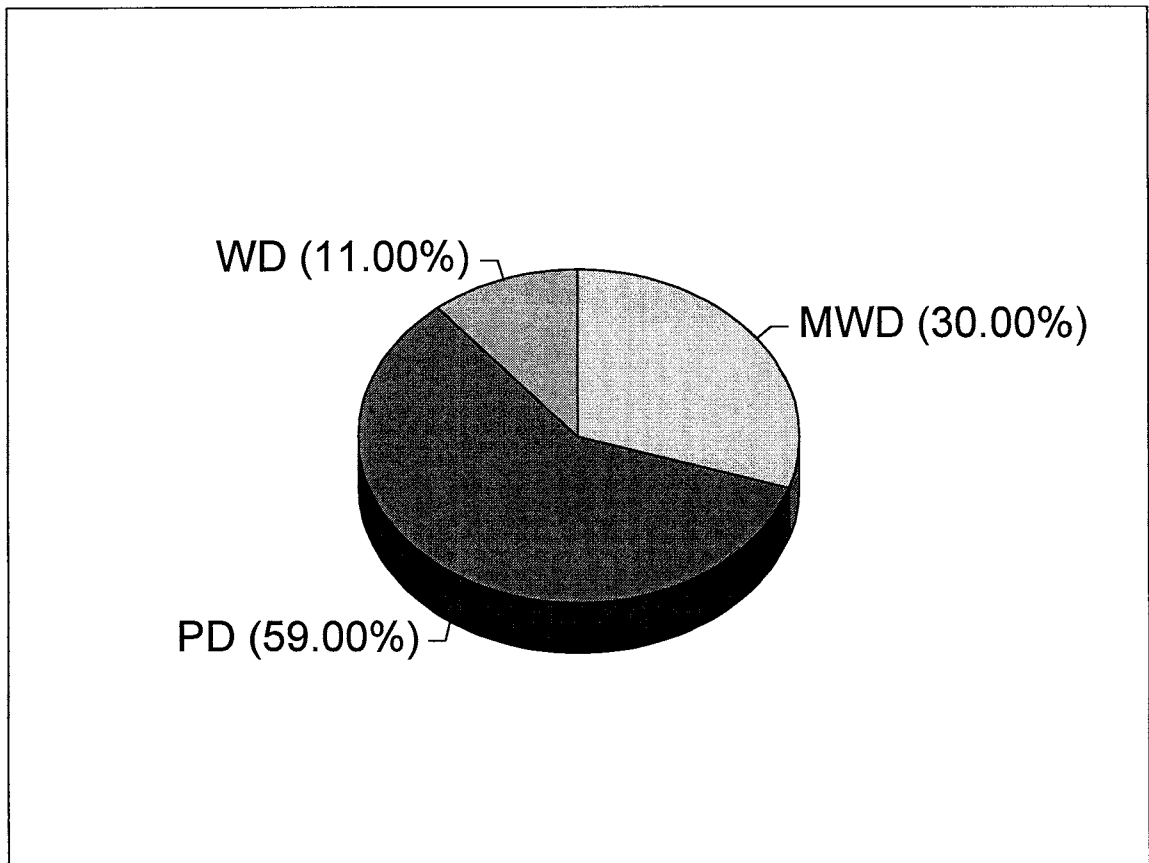


FIGURE A-14. DISTRIBUTION OF SOIL DRAINAGE ON FARM-25.

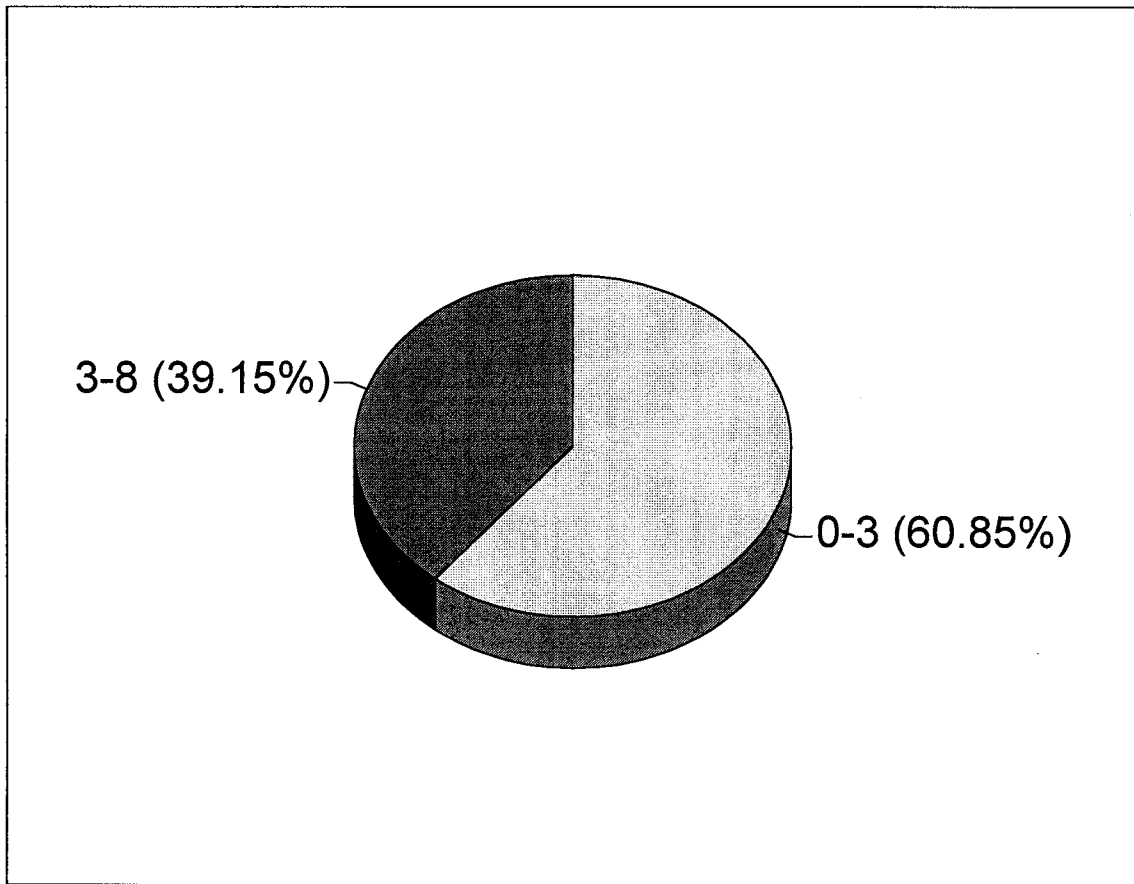


FIGURE A-15. DISTRIBUTION OF SOIL SLOPE ON FARM-11.

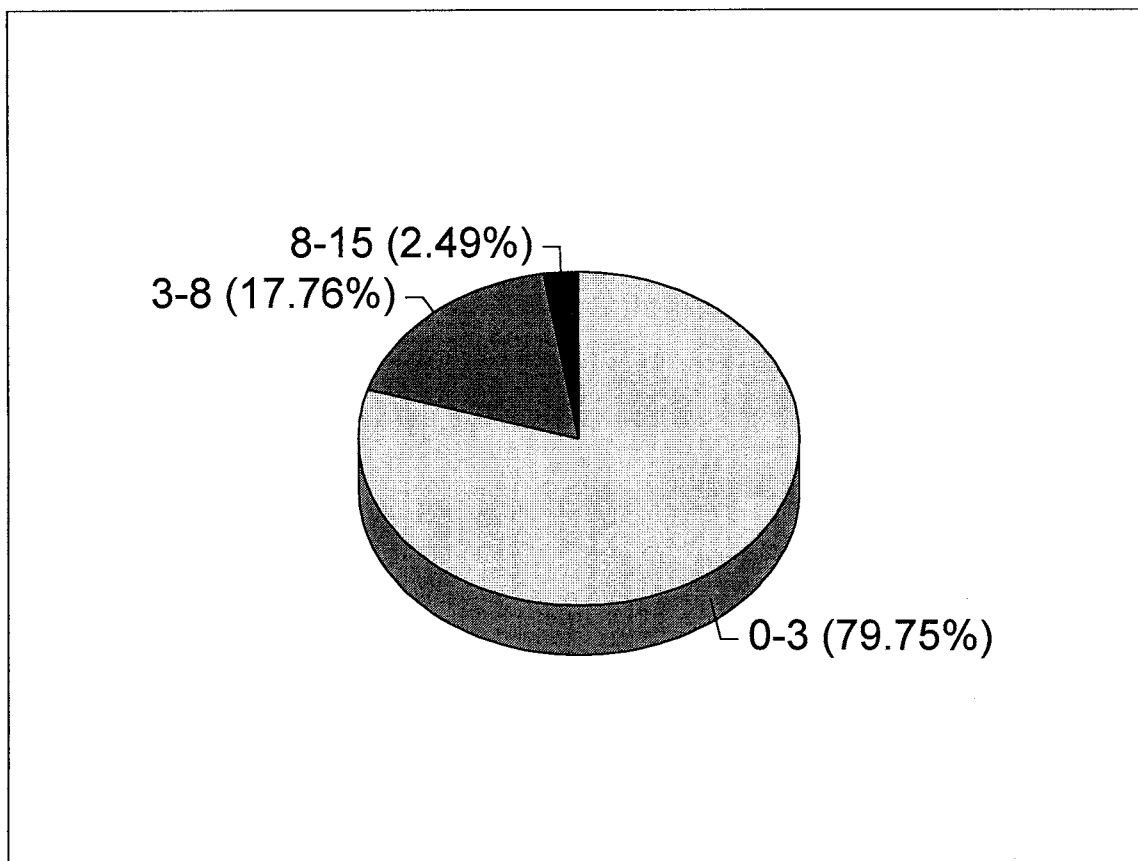


FIGURE A-16. DISTRIBUTION OF SOIL SLOPE ON FARM-12.

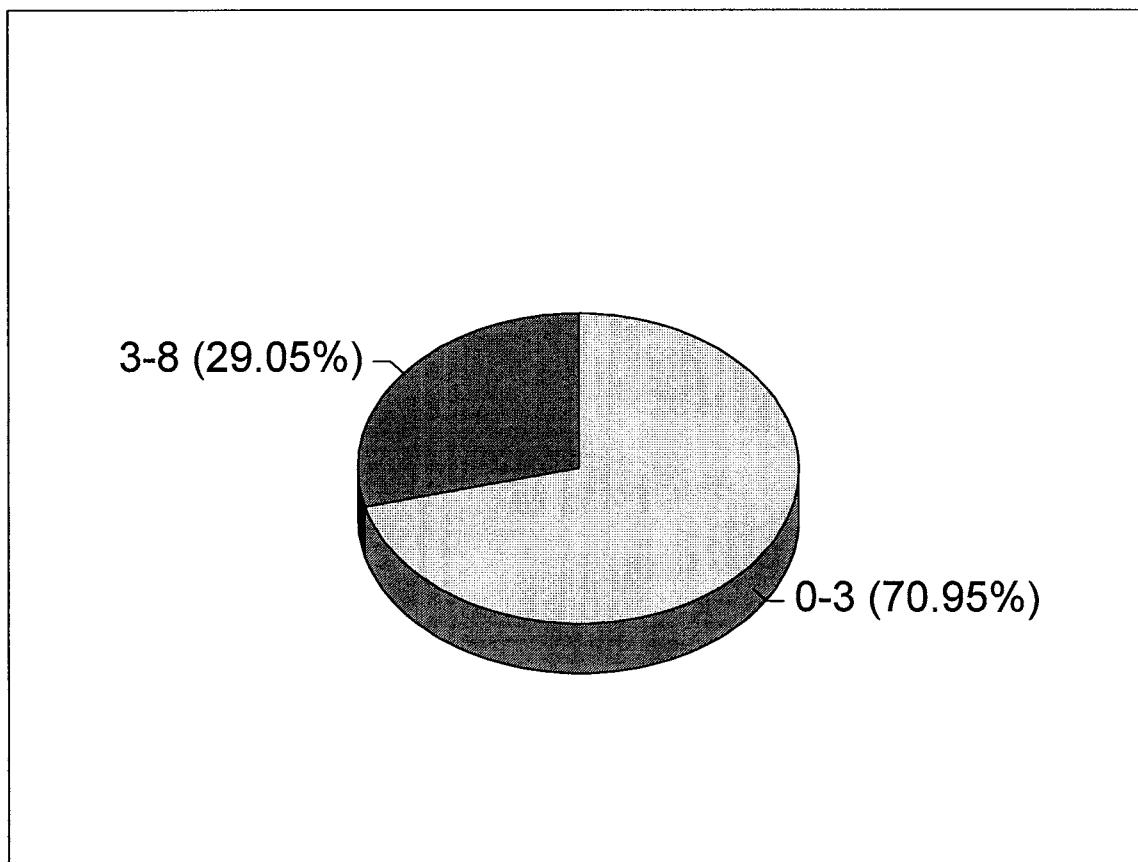


FIGURE A-17. DISTRIBUTION OF SOIL SLOPE ON FARM-21.

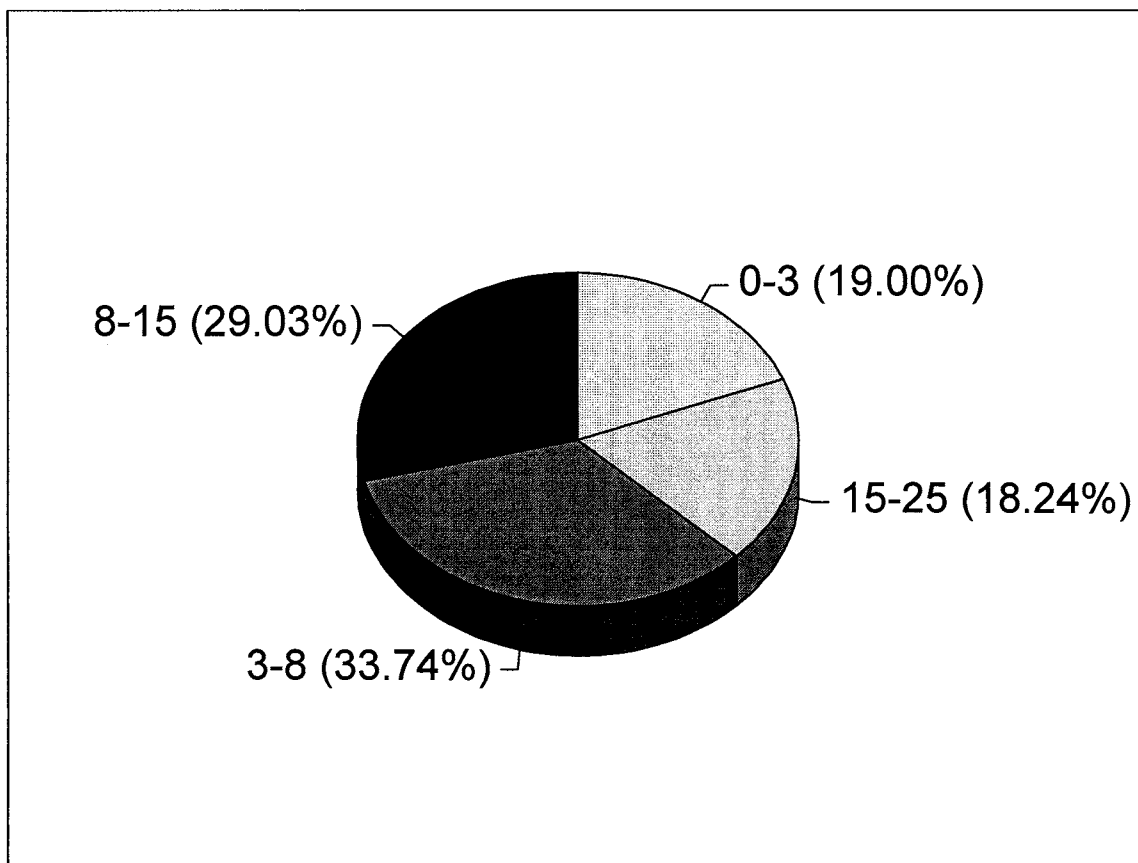


FIGURE A-18. DISTRIBUTION OF SOIL SLOPE ON FARM-22.

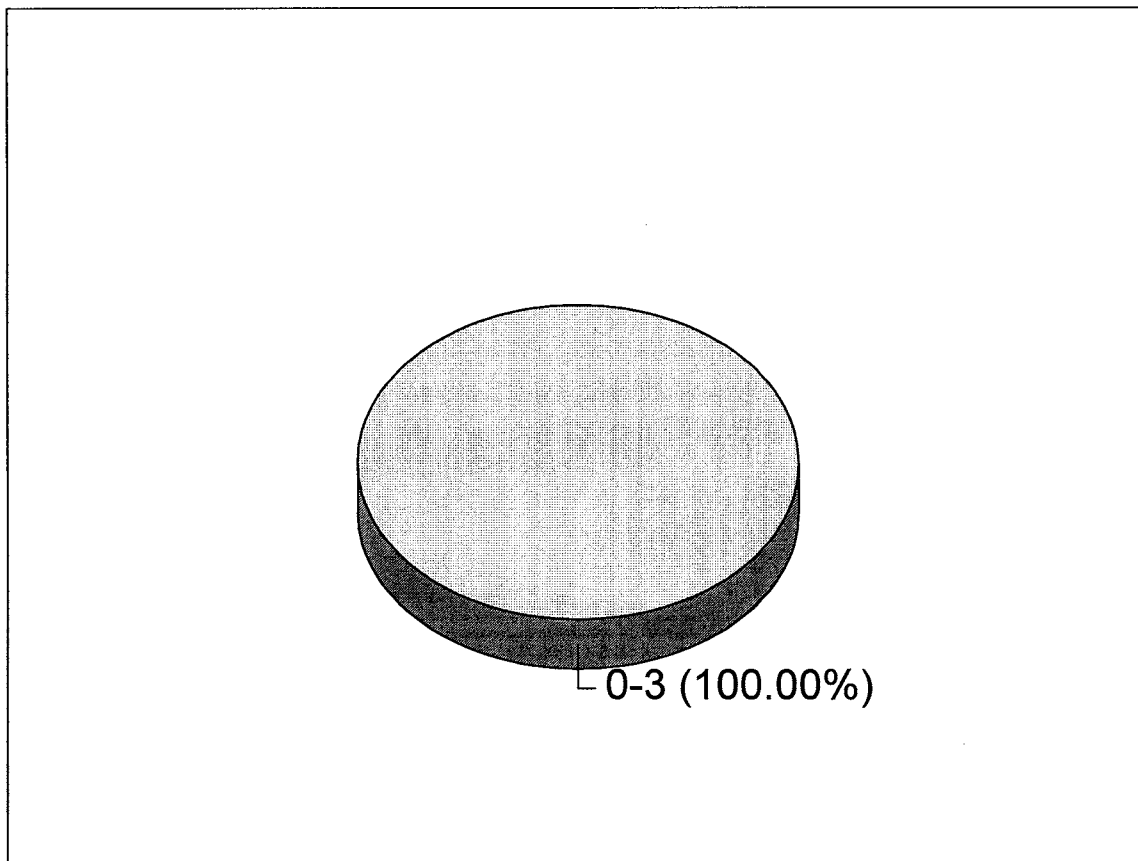


FIGURE A-19. DISTRIBUTION OF SOIL SLOPE ON FARM-23.

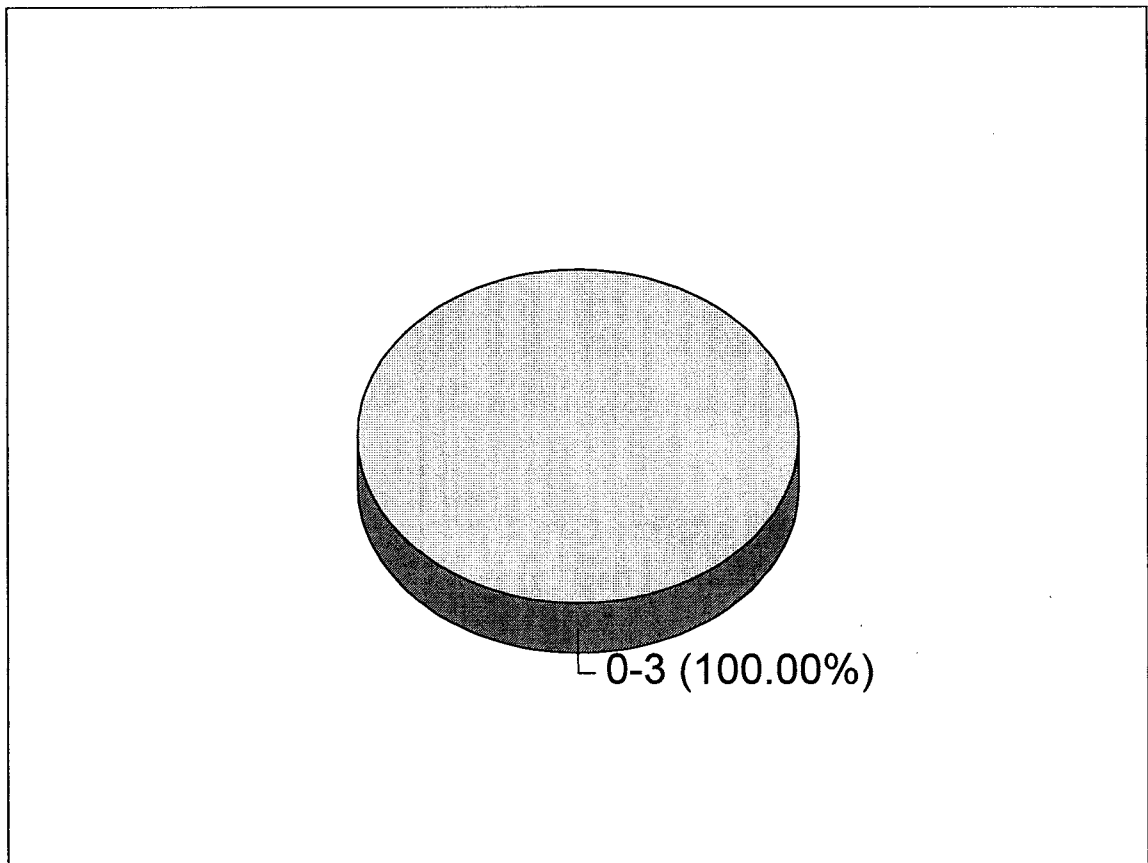


FIGURE A-20. DISTRIBUTION OF SOIL SLOPE ON FARM-24.

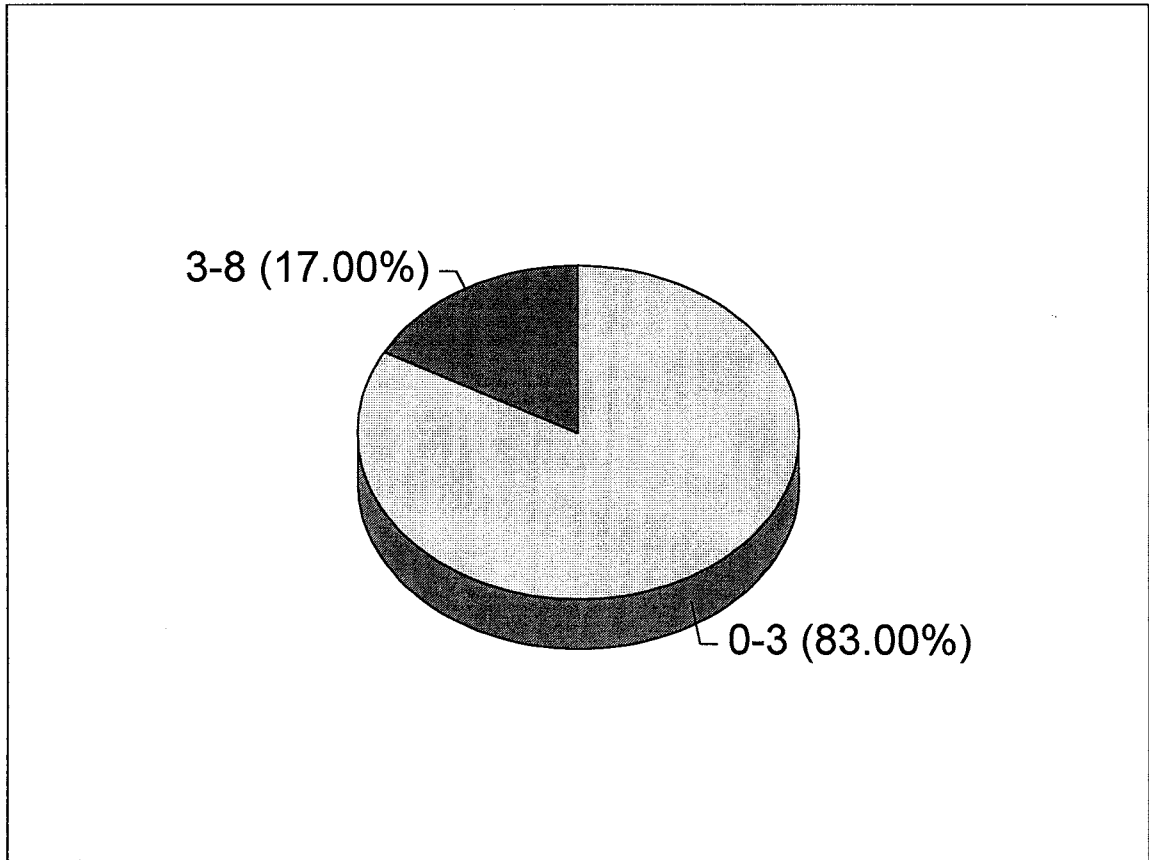


FIGURE A-21. DISTRIBUTION OF SOIL SLOPE ON FARM-25.

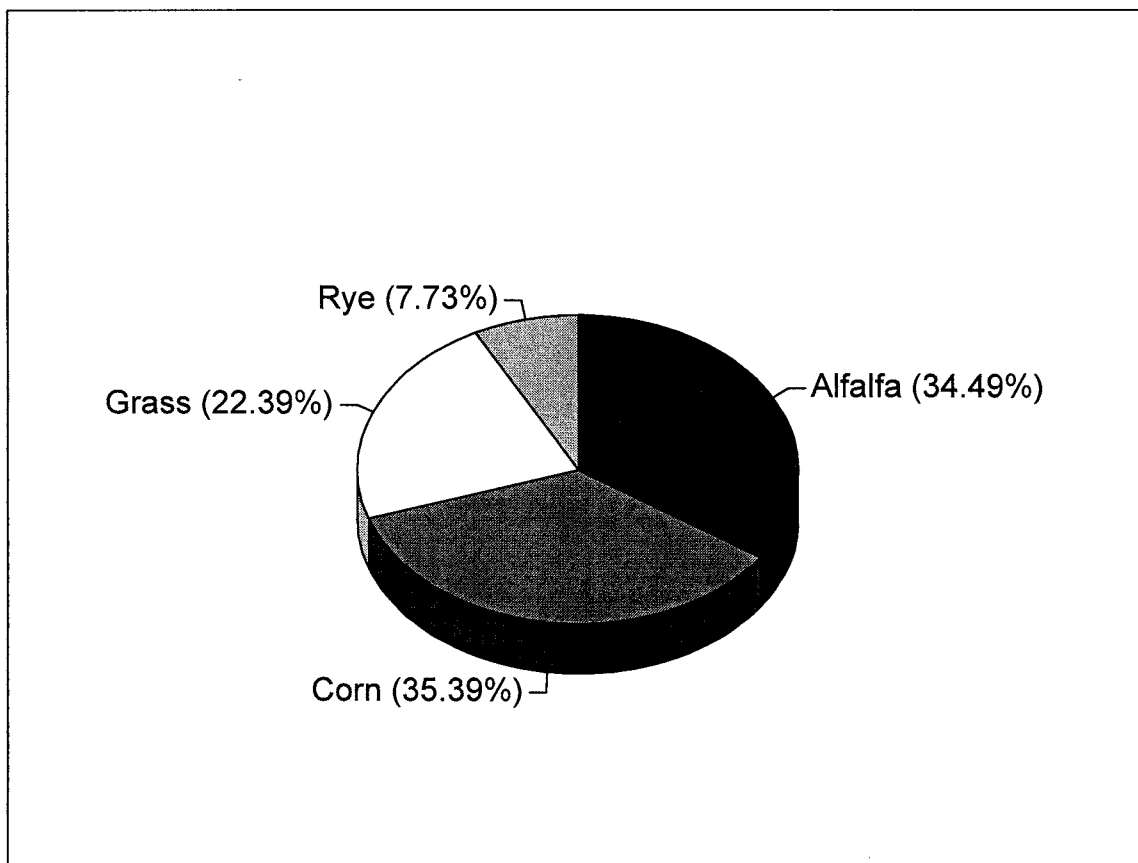


FIGURE A-22. CROP DISTRIBUTION ON FARM-11.

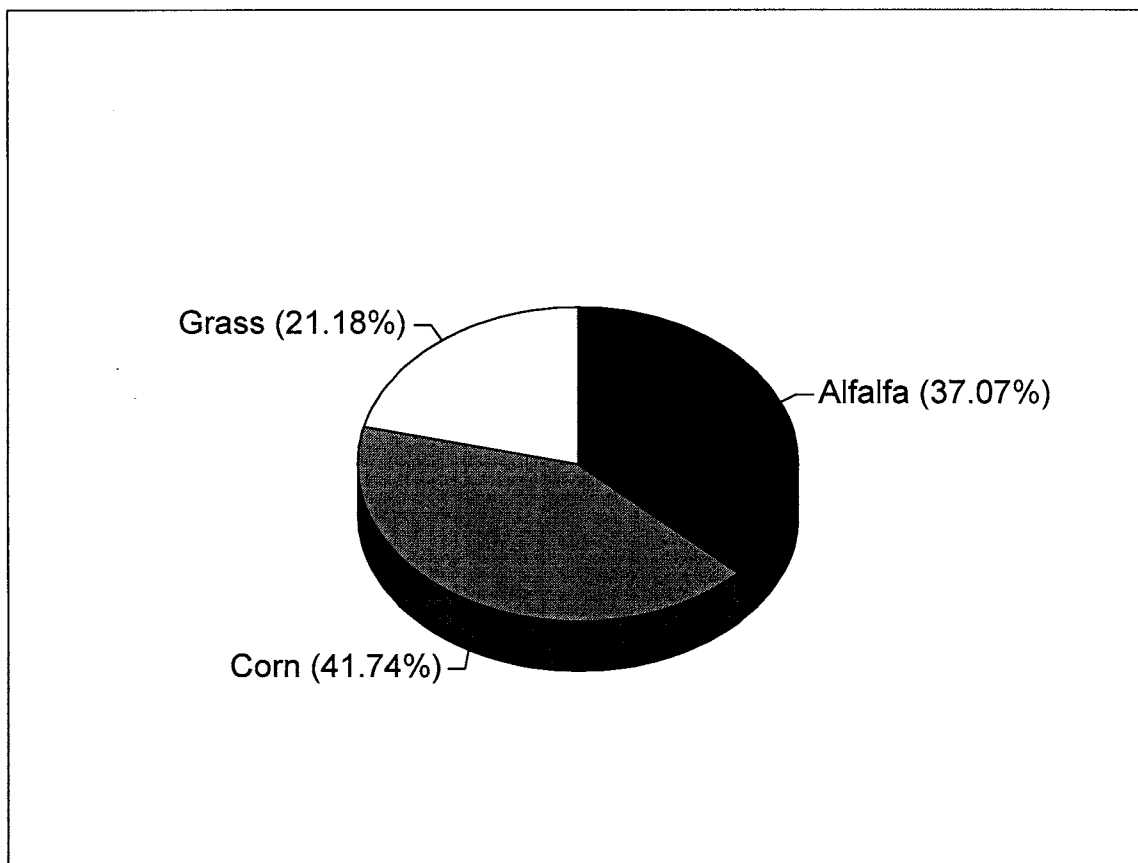


FIGURE A-23. CROP DISTRIBUTION ON FARM-12.

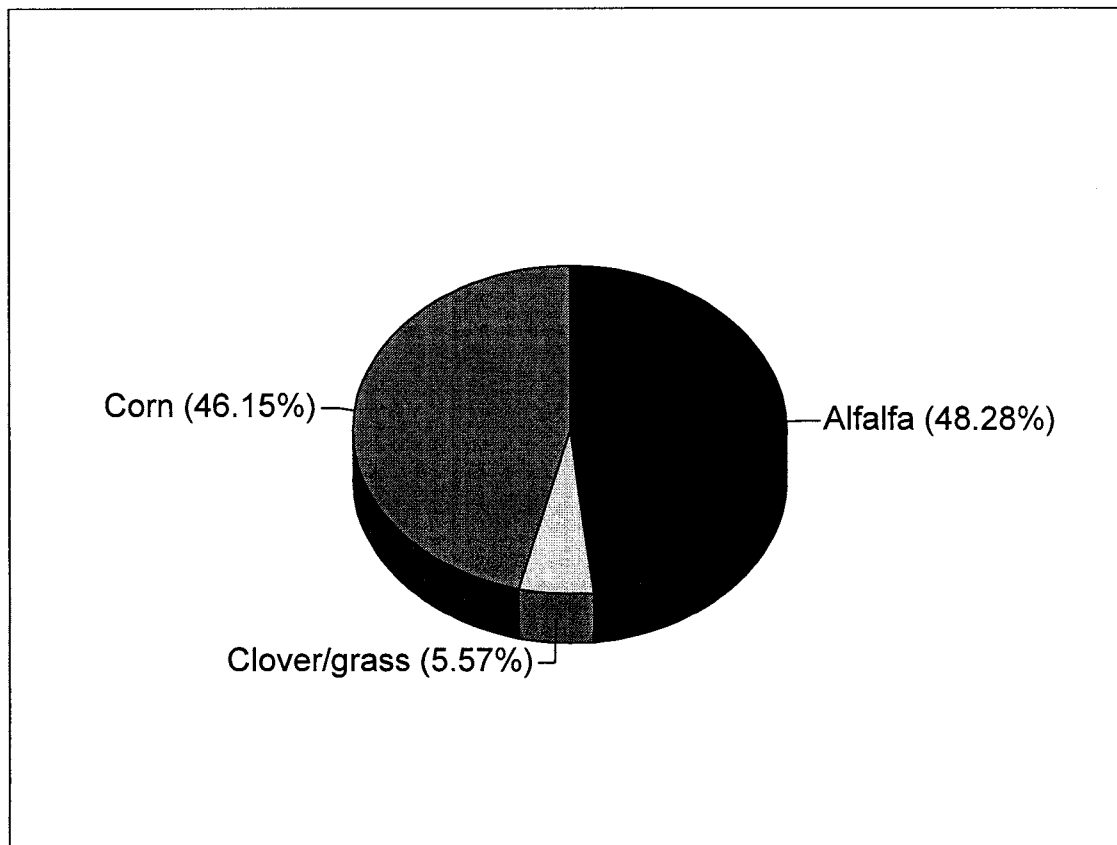


FIGURE A-24. CROP DISTRIBUTION ON FARM-21.

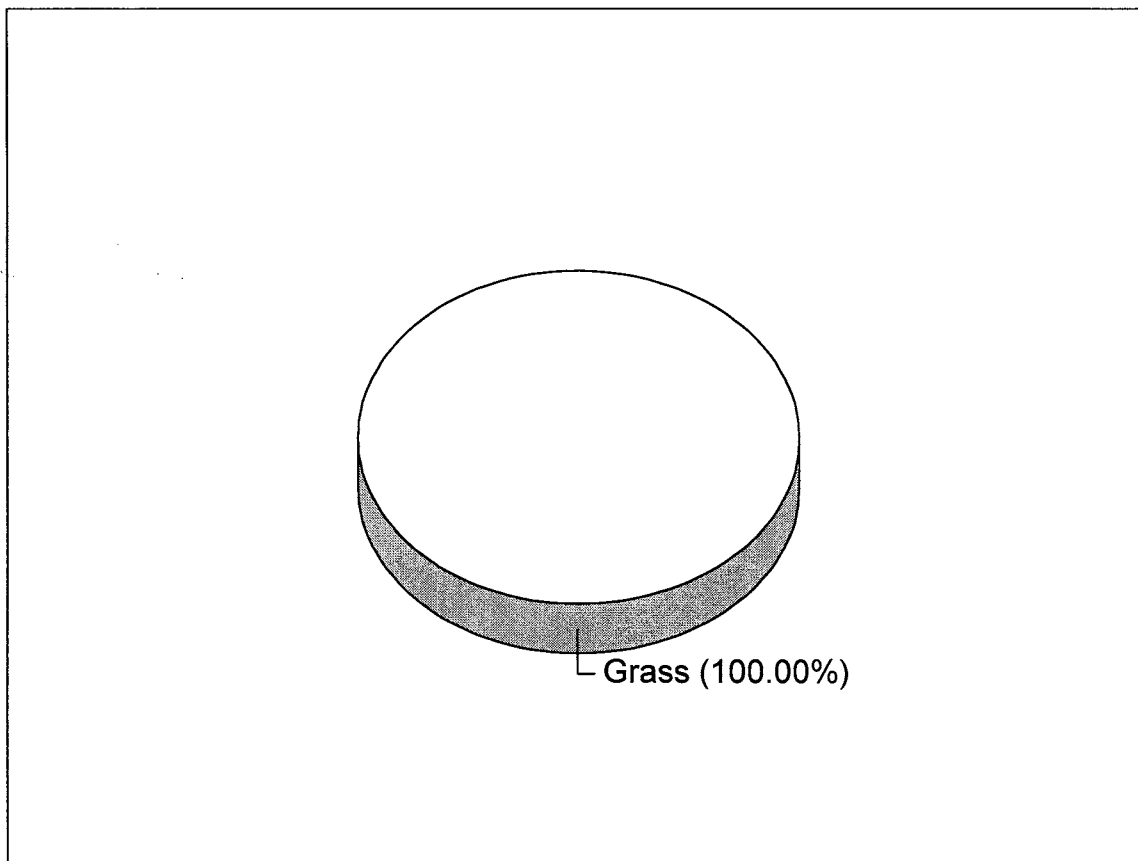


FIGURE A-25. CROP DISTRIBUTION ON FARM-22.

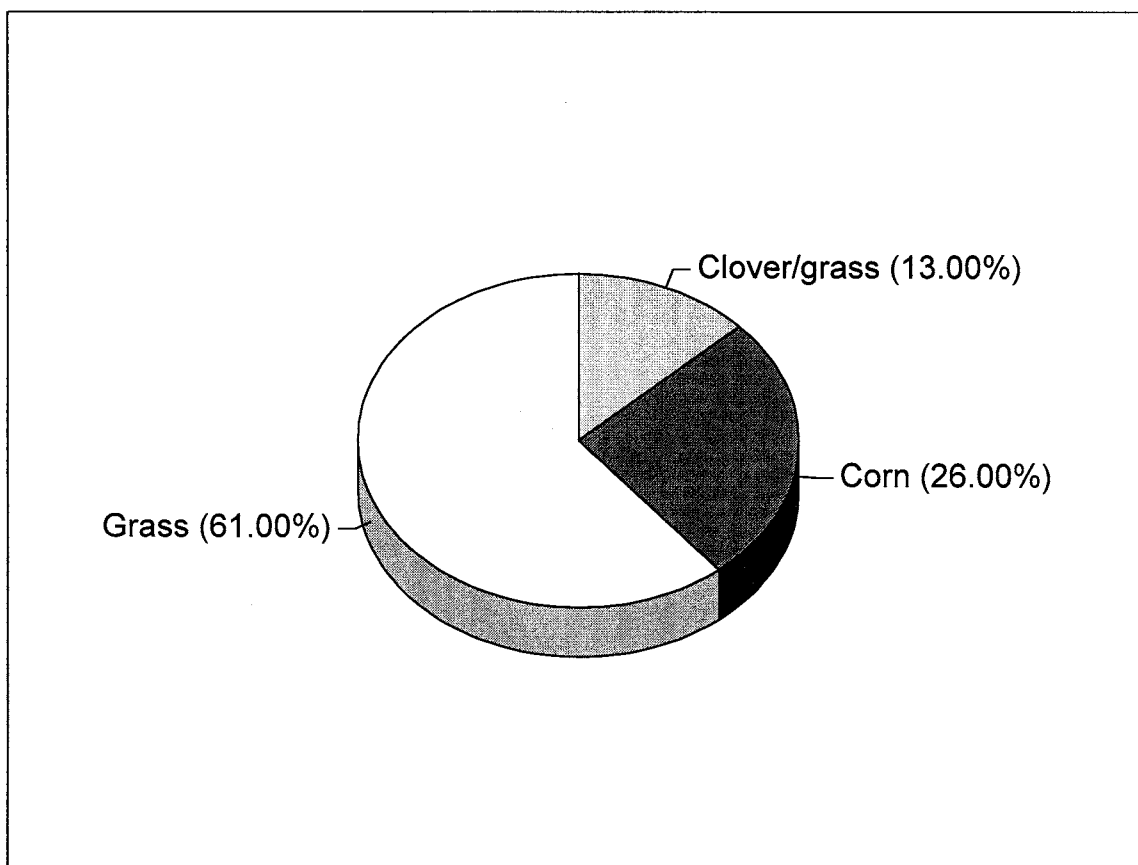


FIGURE A-26. CROP DISTRIBUTION ON FARM-23.

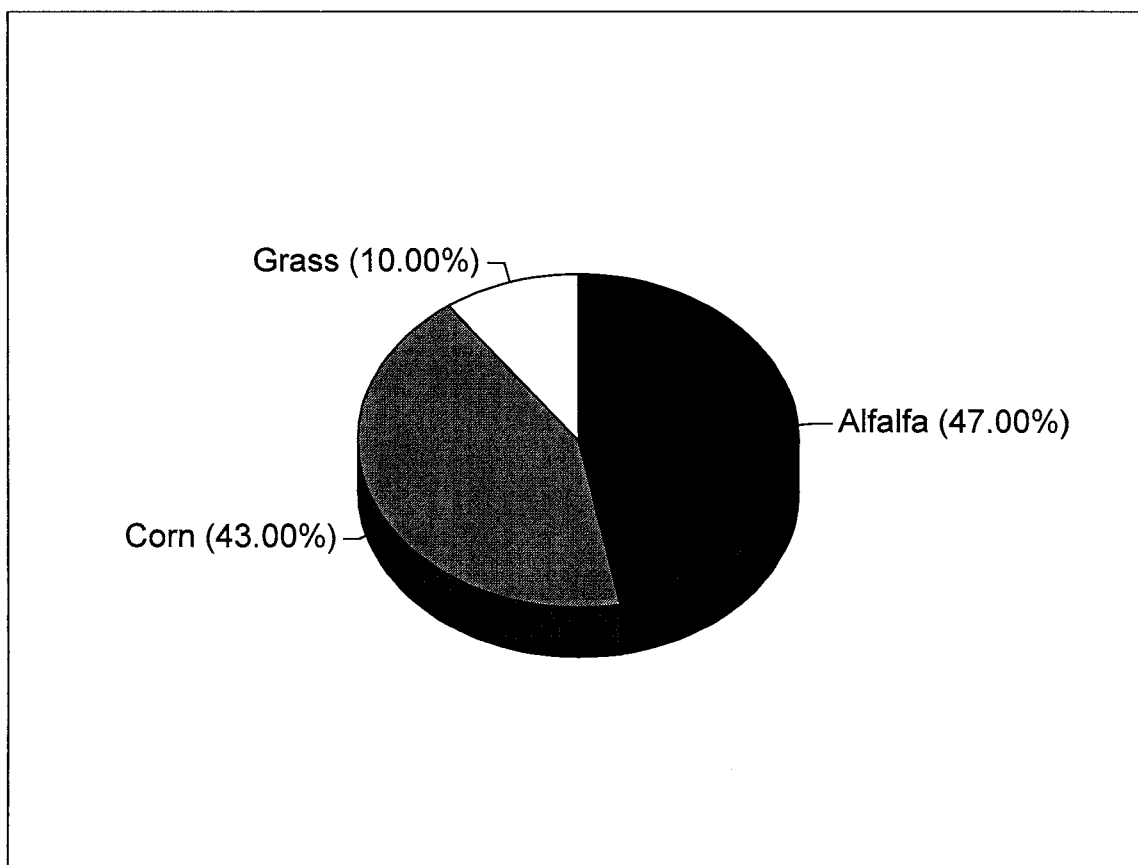


FIGURE A-27. CROP DISTRIBUTION ON FARM-24.

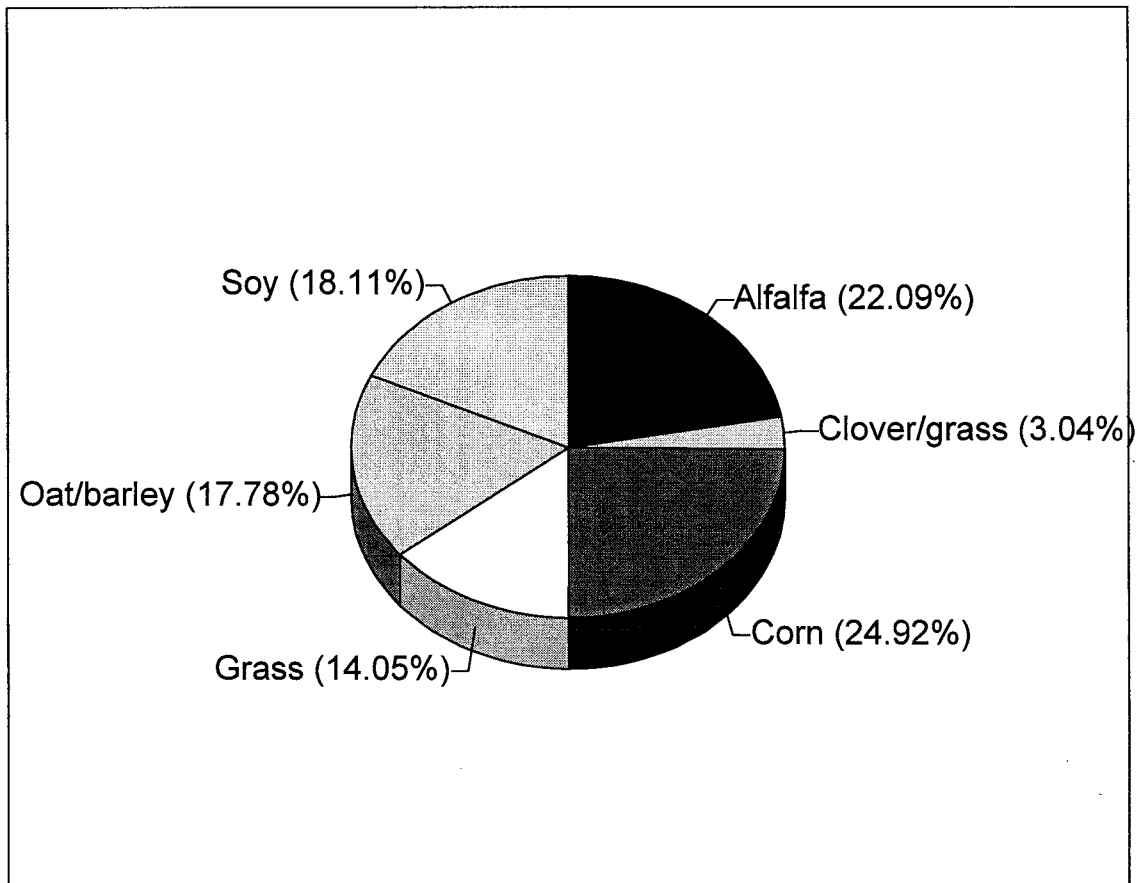


FIGURE A-28. CROP DISTRIBUTION ON FARM-25.

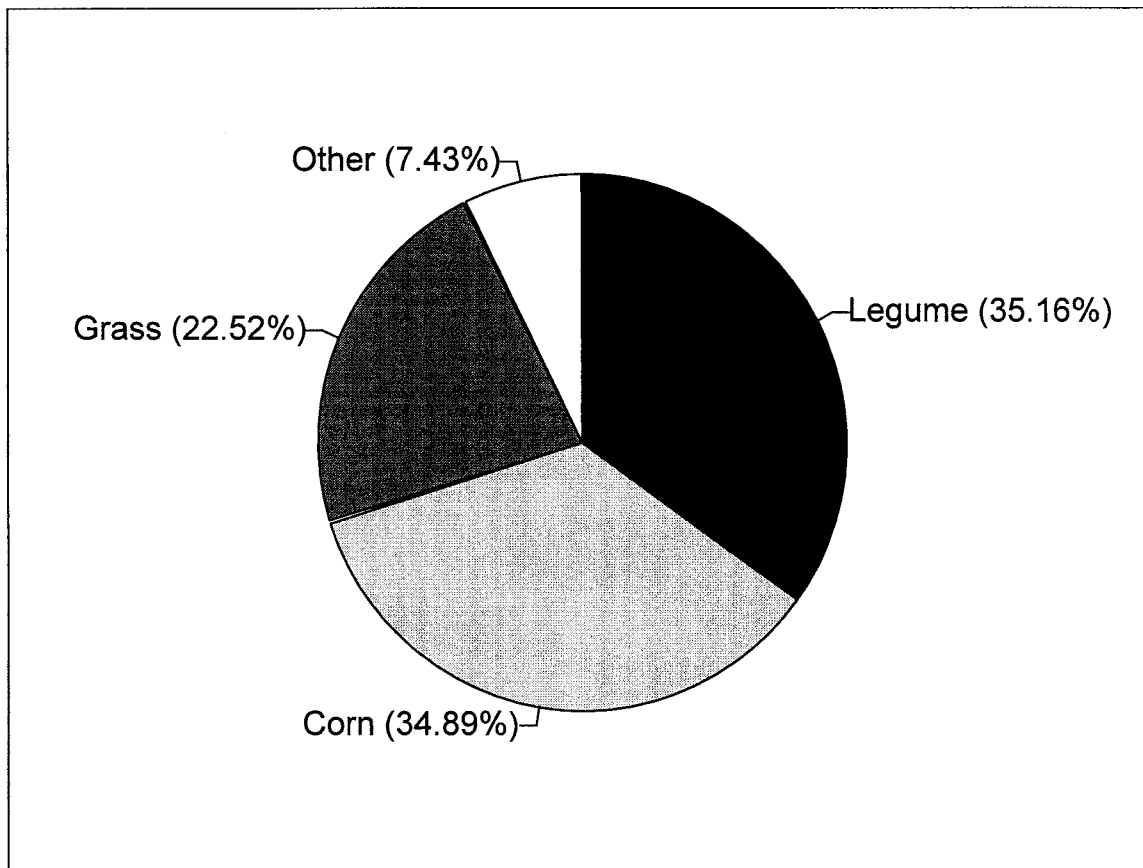


FIGURE A-29. OVERALL CROP DISTRIBUTION FOR SEVEN FARMS IN THE LAKE CHAMPLAIN BASIN.

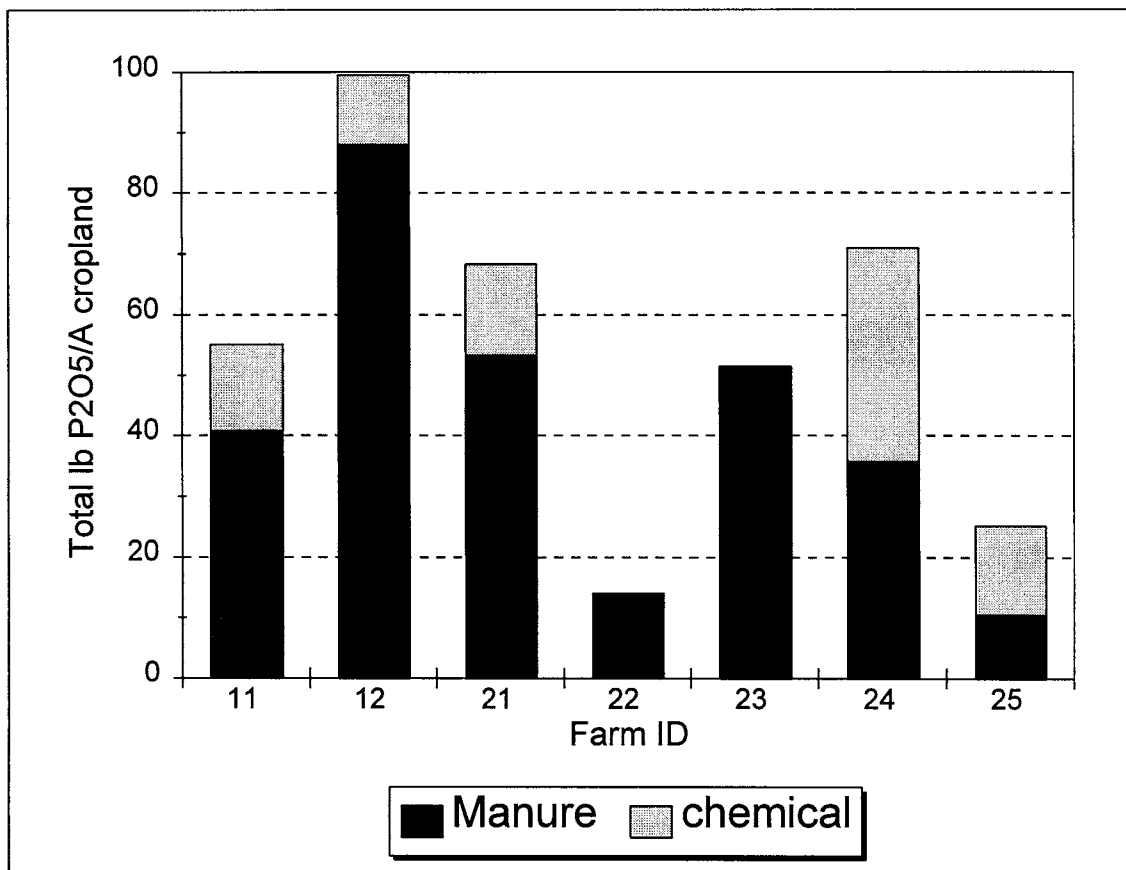


FIGURE A-30. TOTAL P₂O₅ USE ON CROPLAND.

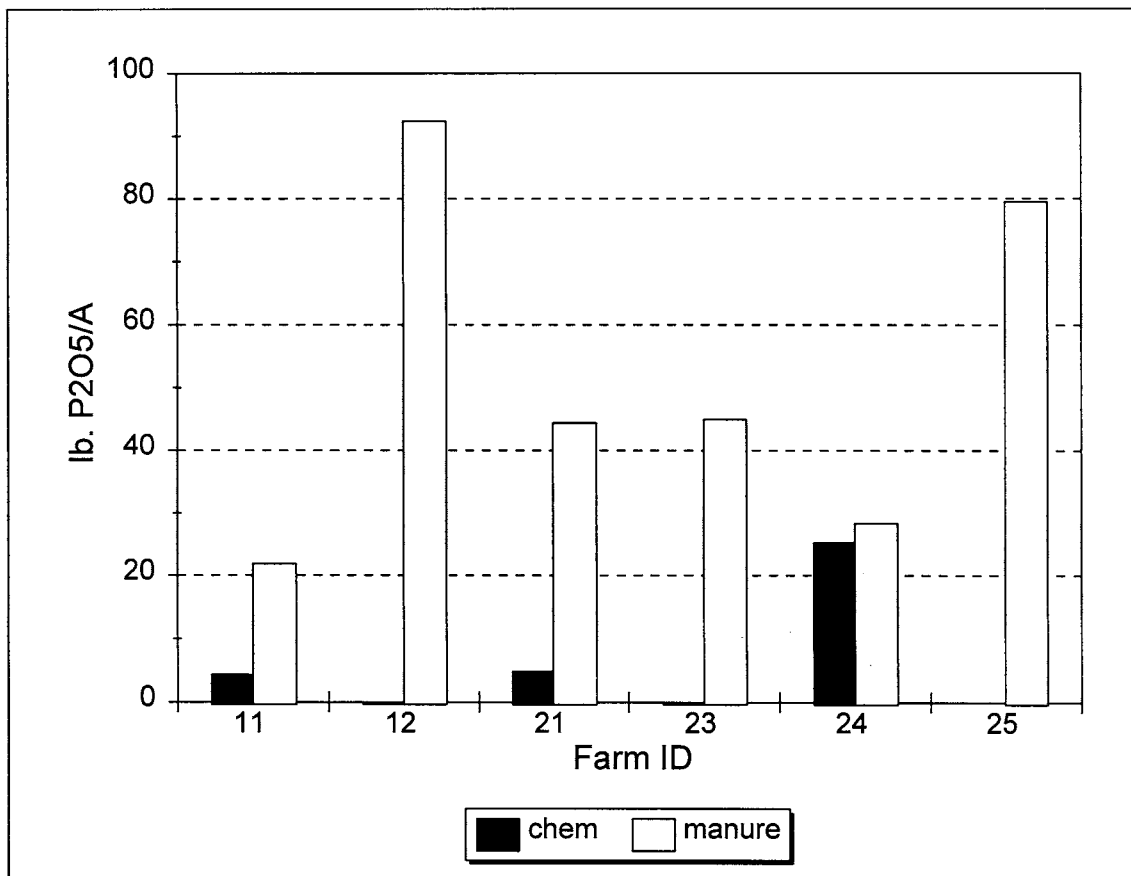


FIGURE A-31. P₂O₅ USE ON LEGUMES AND LEGUME/GRASS MIXES.

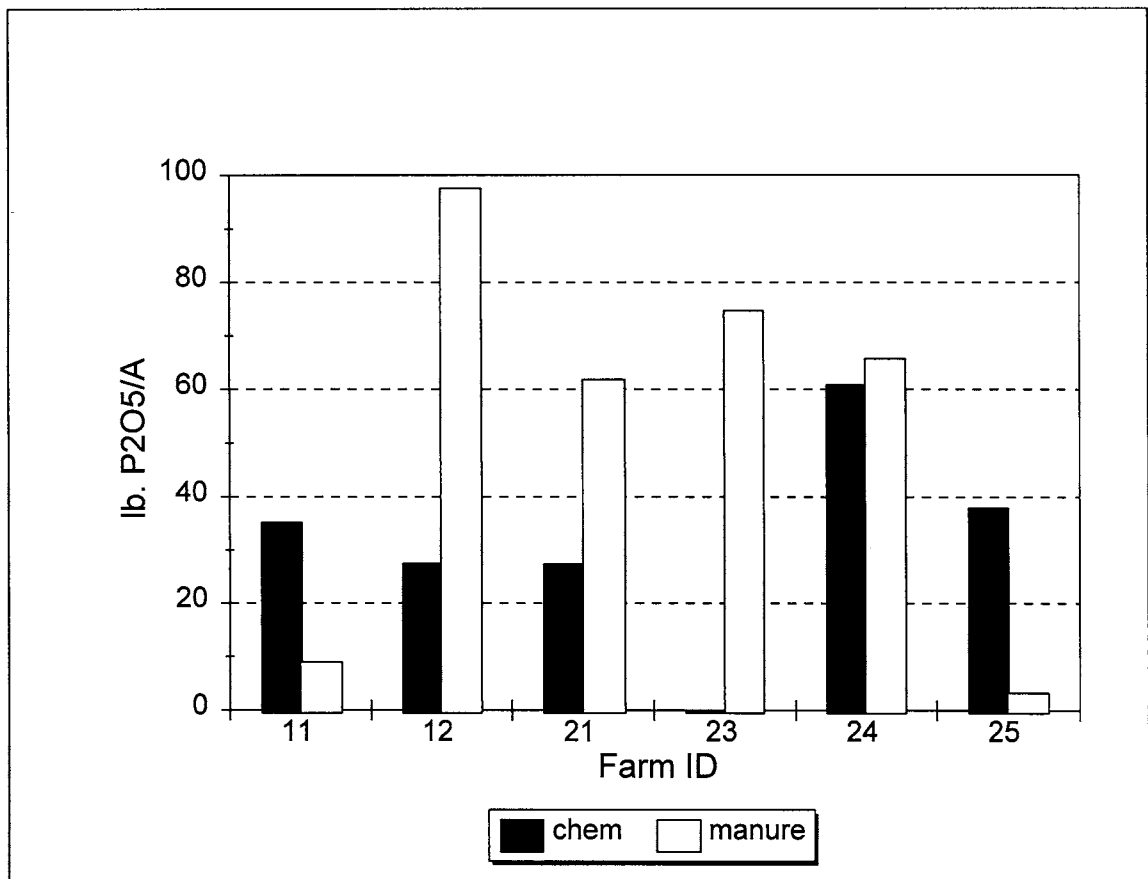


FIGURE A-32. P₂O₅ USE ON CORN.

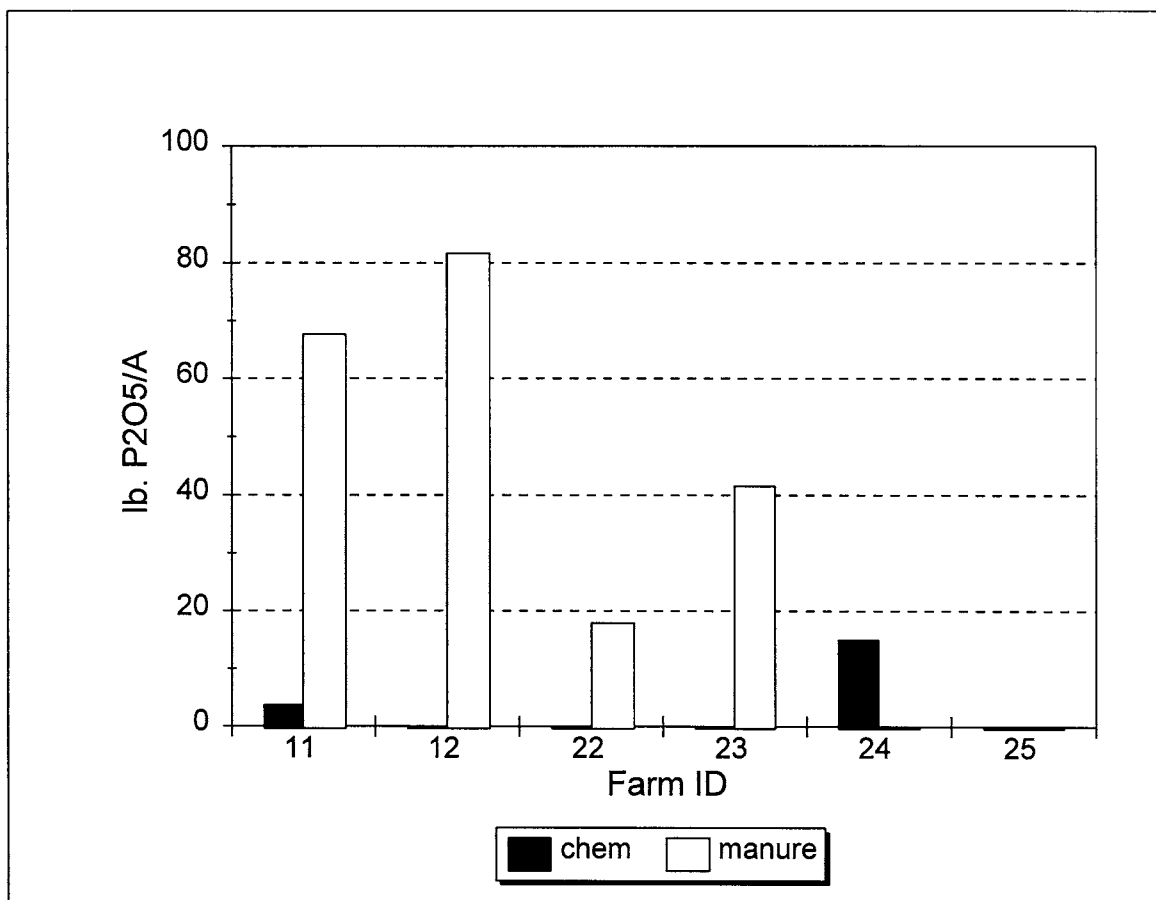


FIGURE A-33. P₂O₅ USE ON GRASS.

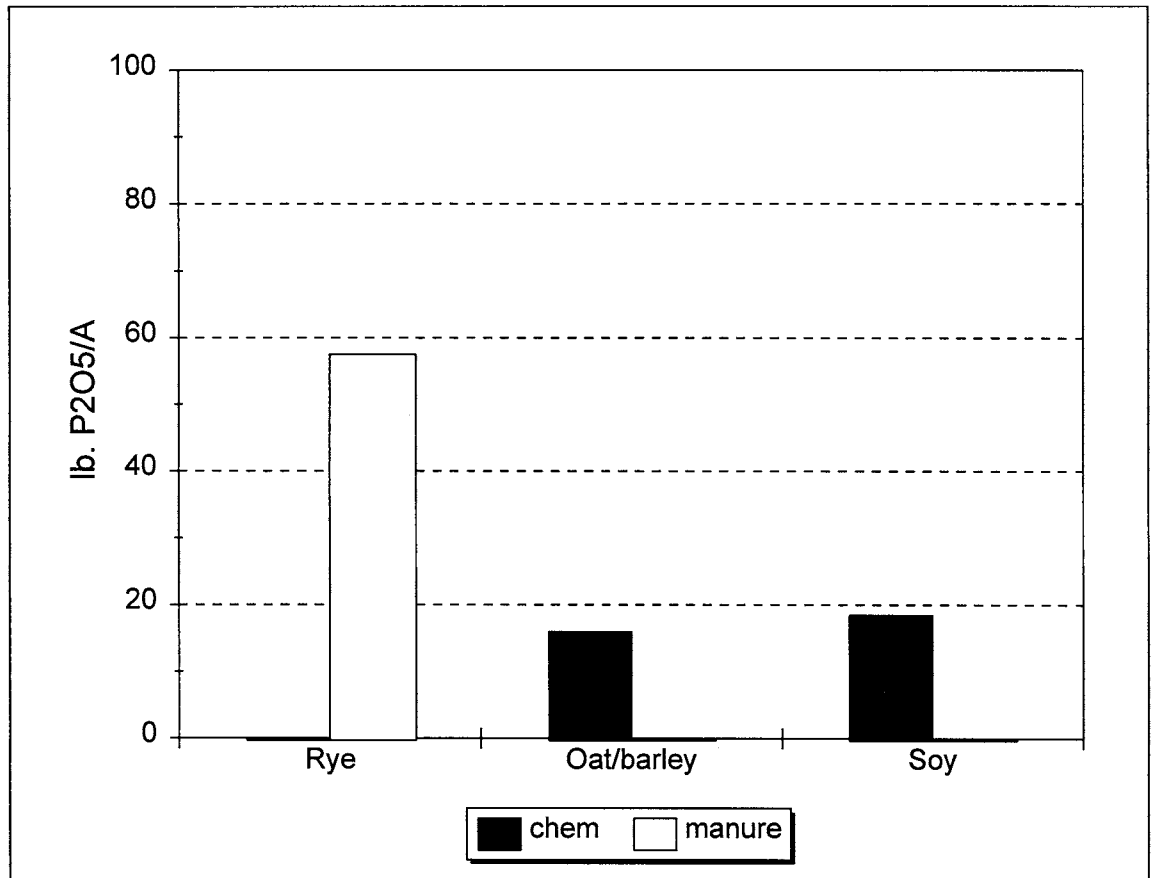


FIGURE A-34. P₂O₅ USE ON OTHER CROPS.

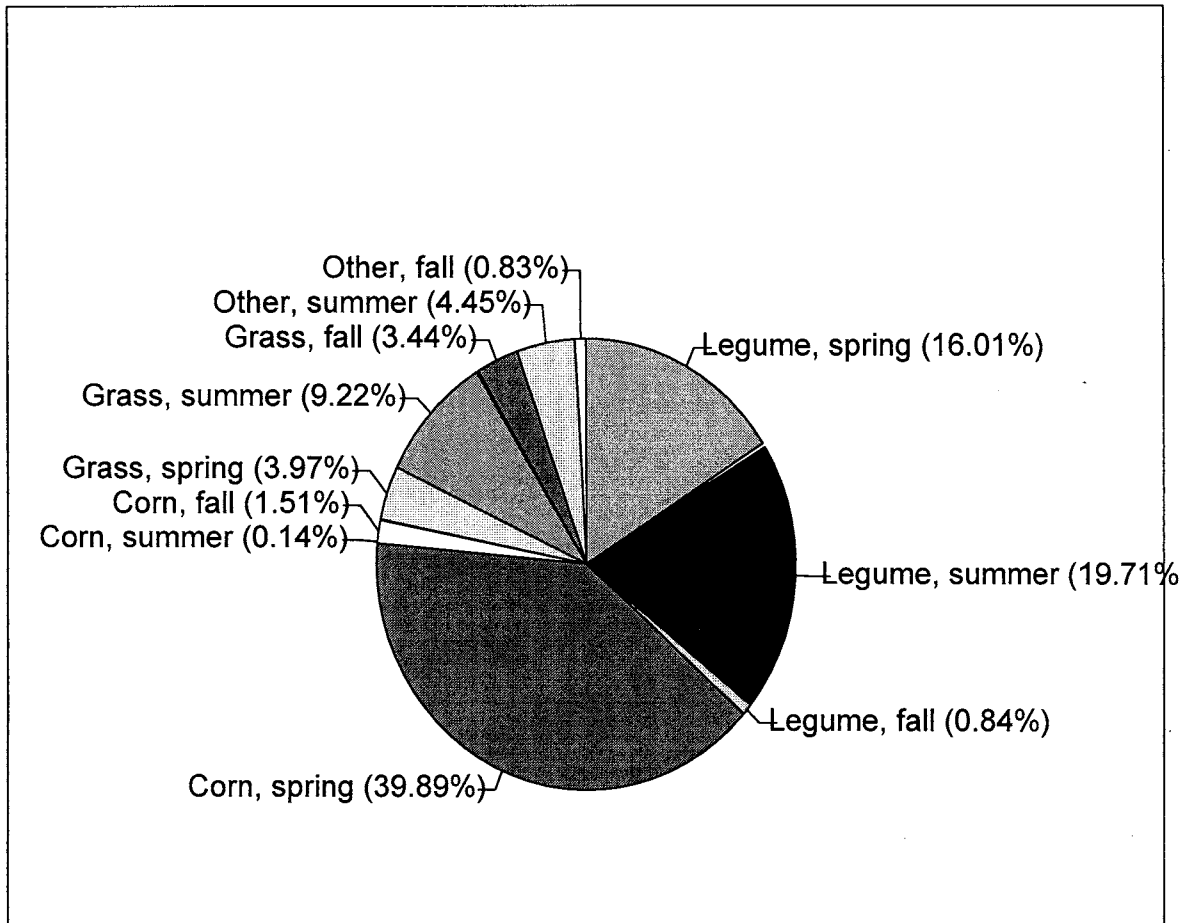


FIGURE A-35. DISTRIBUTION OF P₂O₅ FROM MANURE BY CROP AND SEASON FOR SEVEN FARMS IN THE LAKE CHAMPLAIN BASIN.

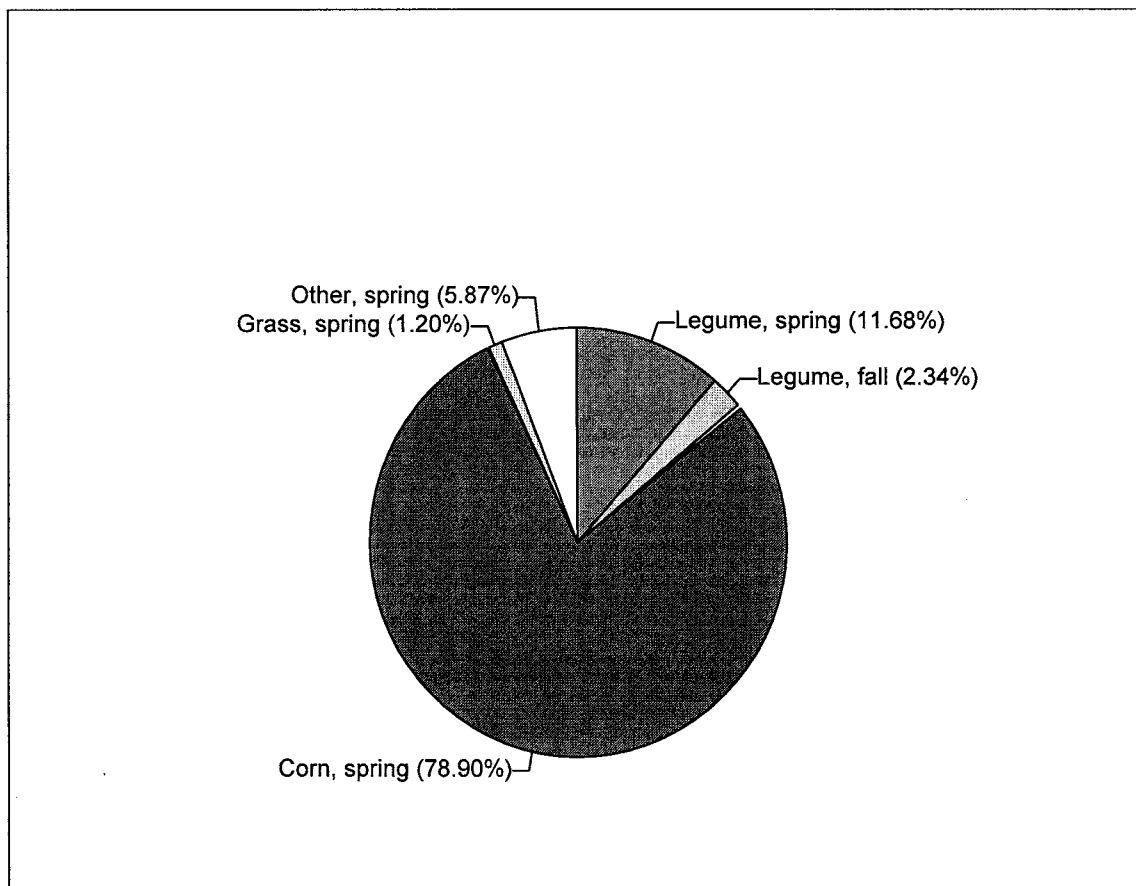


FIGURE A-36. DISTRIBUTION OF P_2O_5 FROM CHEMICAL FERTILIZER BY CROP AND SEASON FOR SEVEN FARMS IN THE LAKE CHAMPLAIN BASIN.

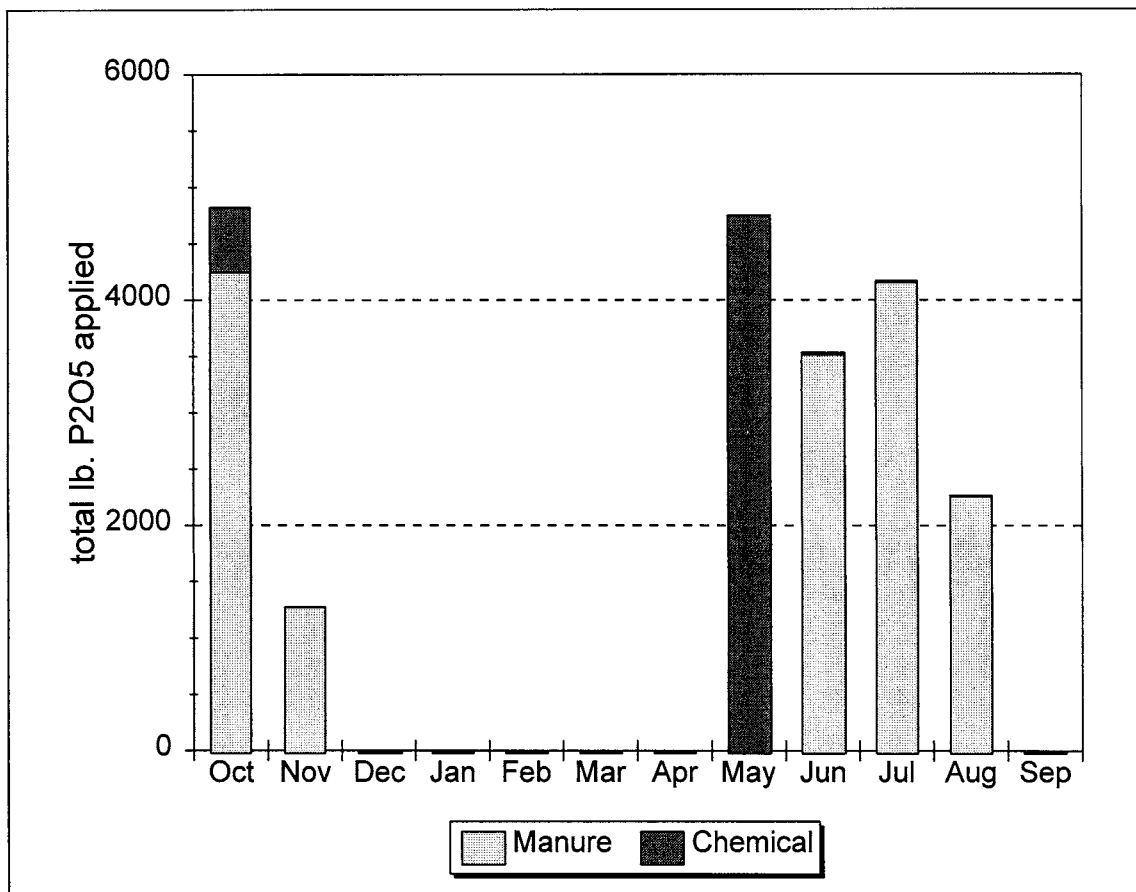


FIGURE A-37. SEASONAL DISTRIBUTION OF P₂O₅ APPLICATIONS ON FARM-11.

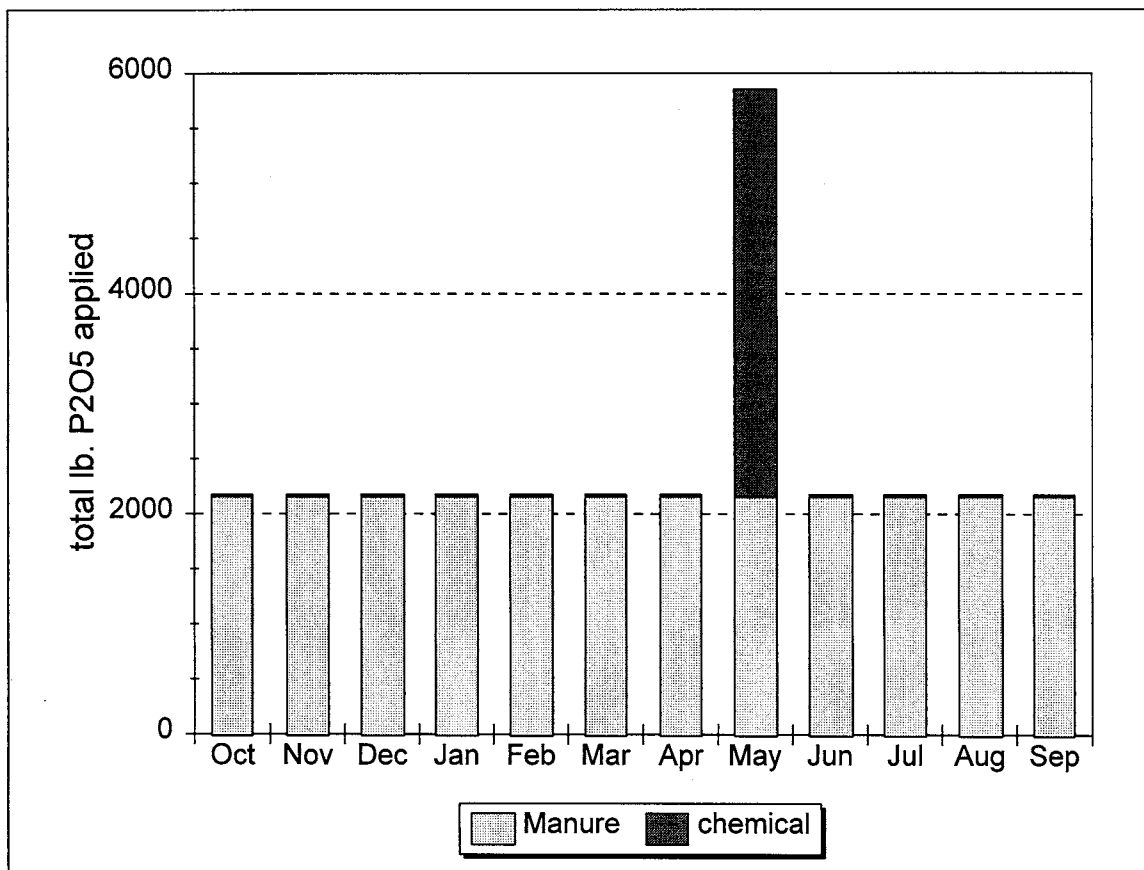


FIGURE A-38. SEASONAL DISTRIBUTION OF P₂O₅ APPLICATIONS ON FARM-12.

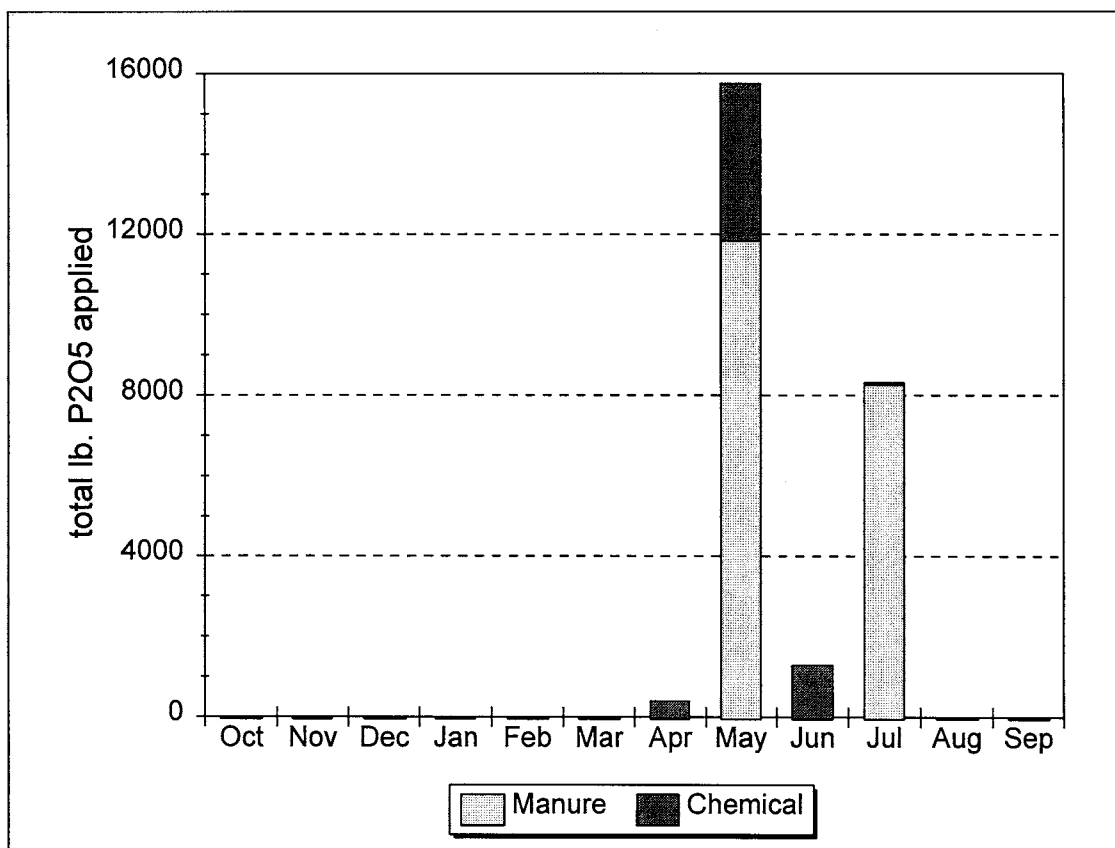


FIGURE A-39. SEASONAL DISTRIBUTION OF P₂O₅ APPLICATIONS ON FARM-21.

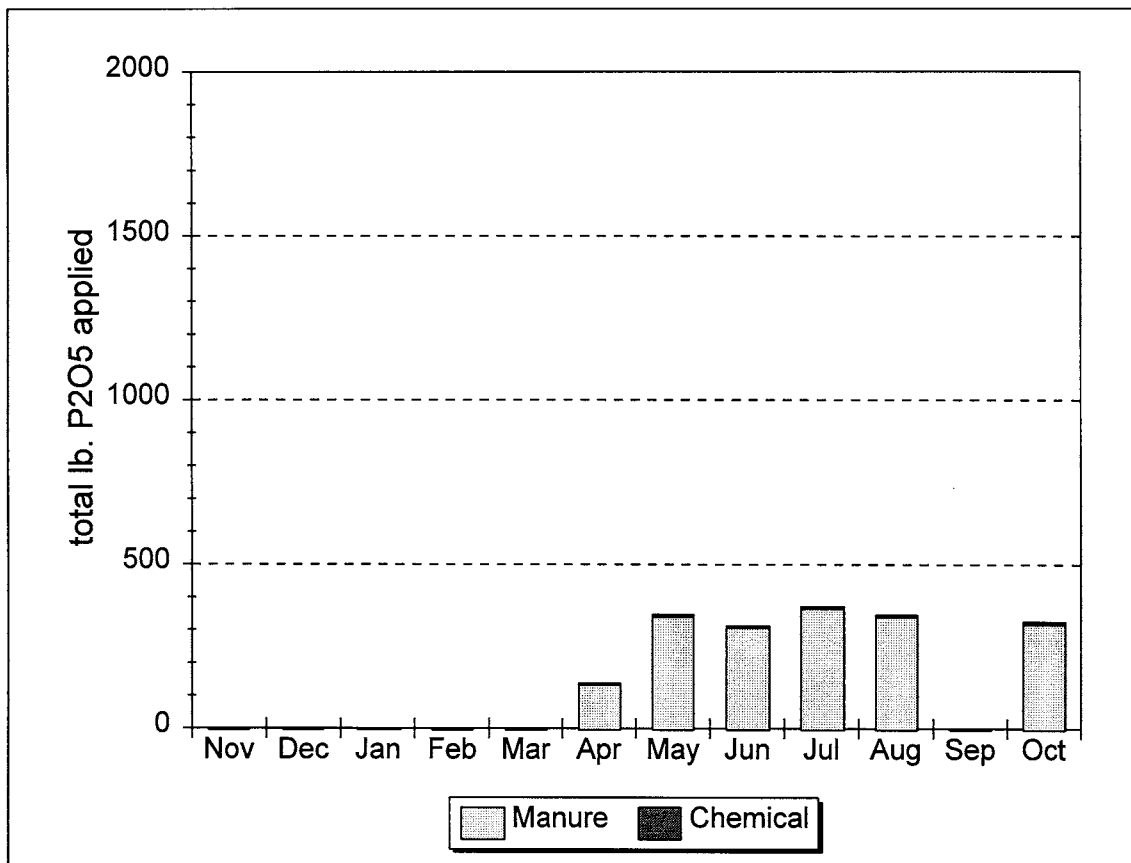


FIGURE A-40. SEASONAL DISTRIBUTION OF P₂O₅ APPLICATIONS ON FARM-22.

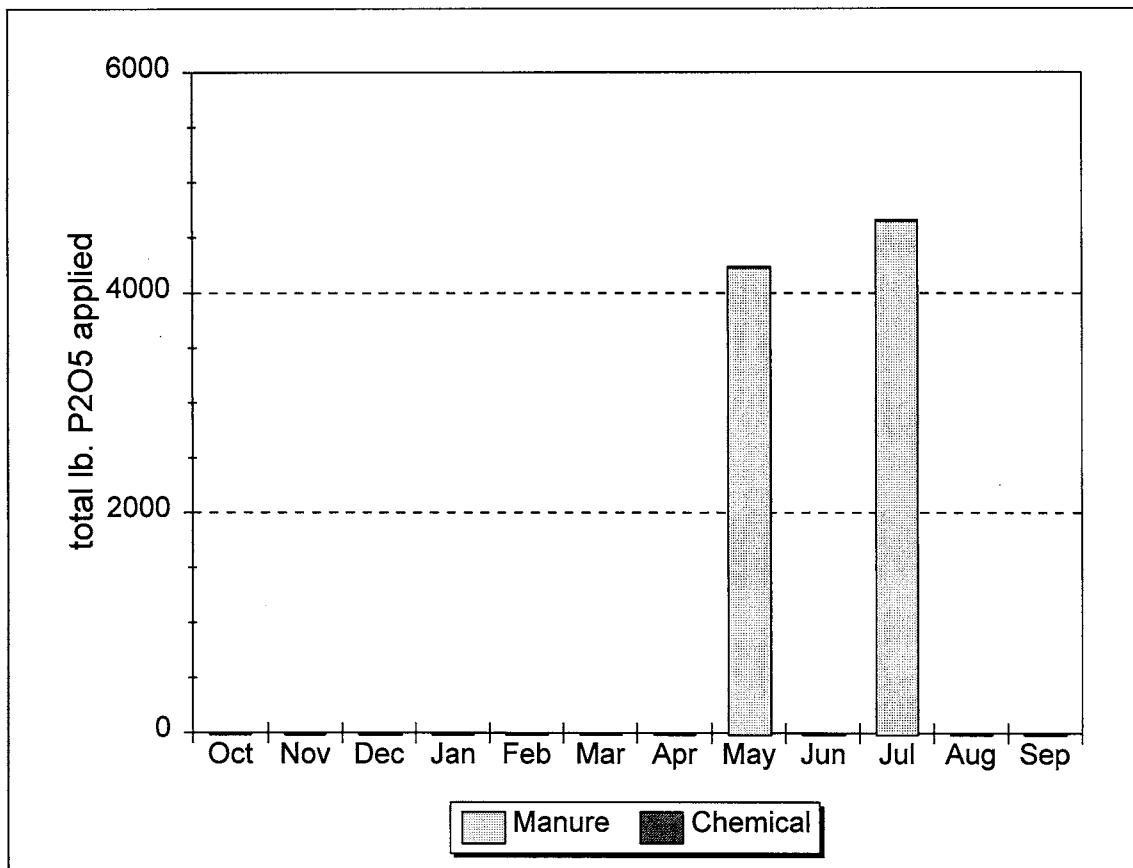


FIGURE A-41. SEASONAL DISTRIBUTION OF P₂O₅ APPLICATIONS ON FARM-23.

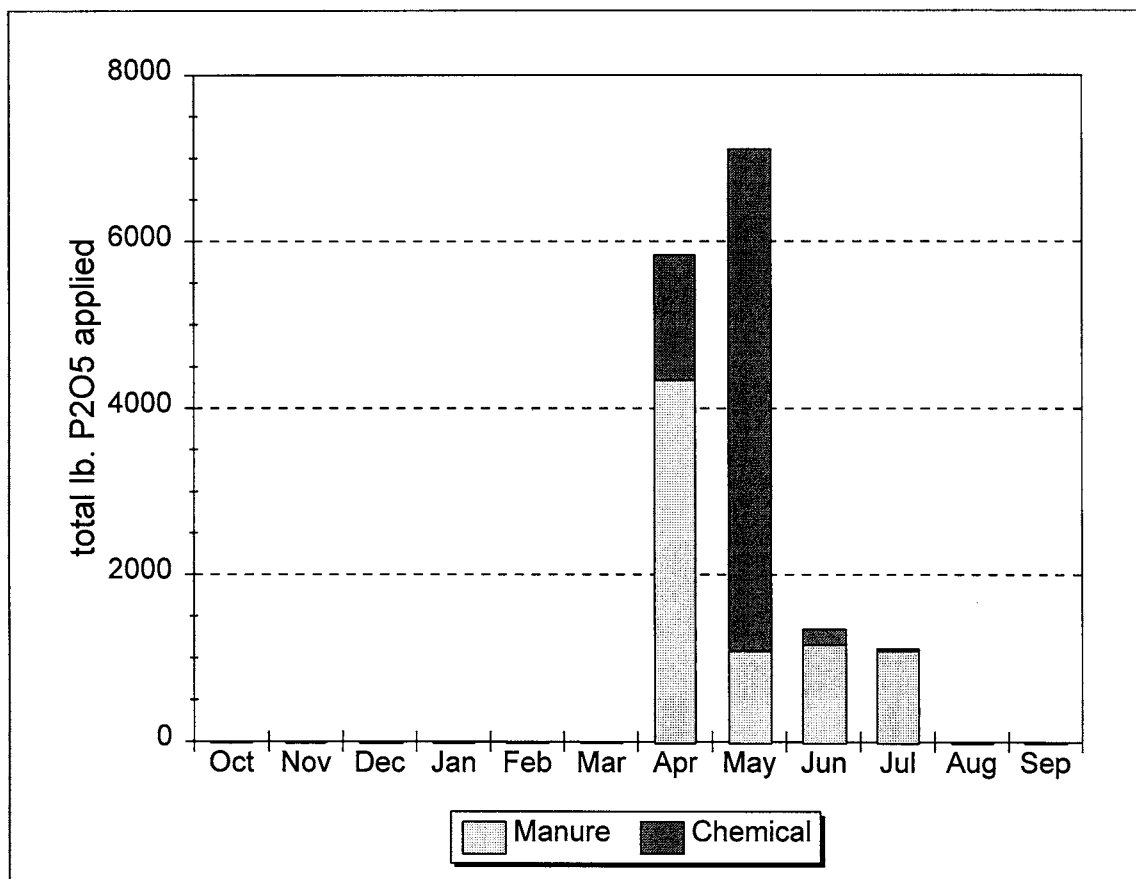


FIGURE A-43. SEASONAL DISTRIBUTION OF P₂O₅ APPLICATIONS ON FARM-24.

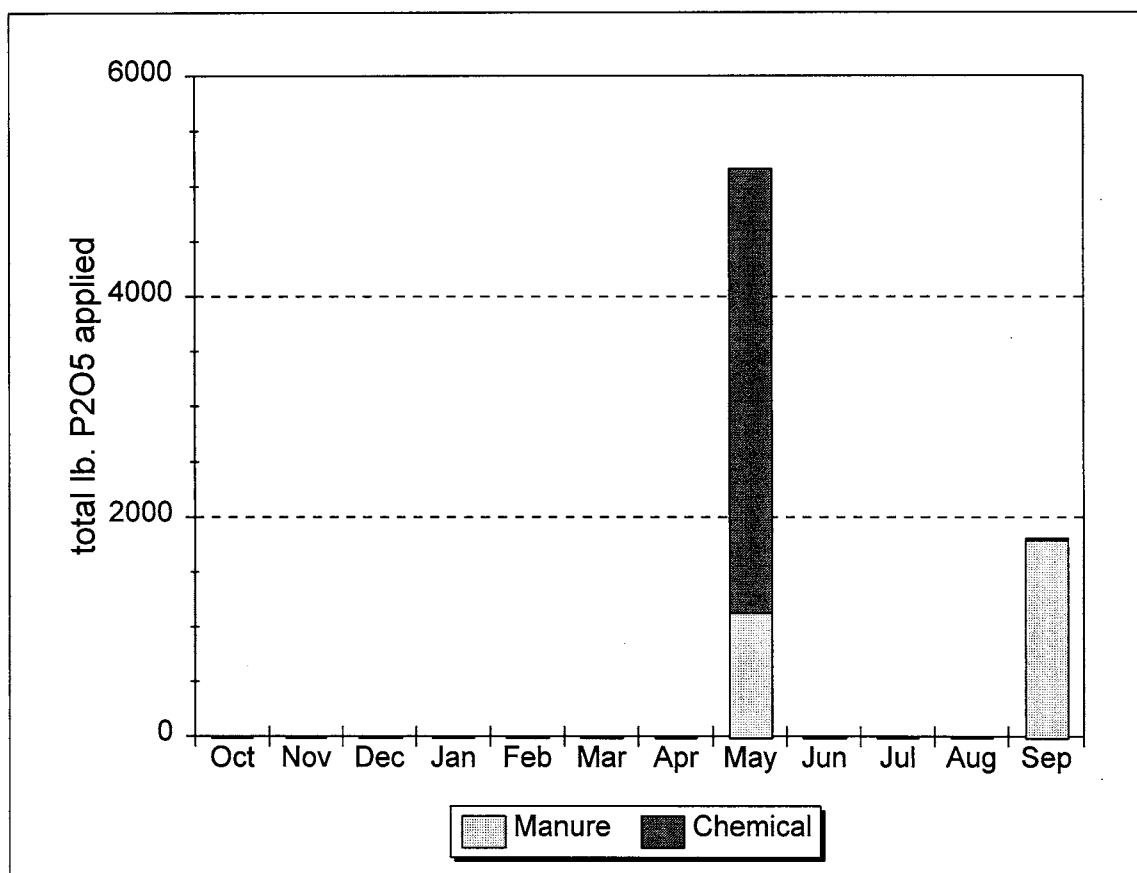


FIGURE A-43. SEASONAL DISTRIBUTION OF P₂O₅ APPLICATIONS ON FARM-25.

TABLE A-9. FIELD INFORMATION FOR THE SEVEN FARMS IN THE
ON-FARM PHOSPHORUS STUDY

CODE	FIELD	ACRES	SOIL TYPE	SLOPE	DRAINAGE	TEXTURE
11	A-10	11.5	Carlisle A	0-3	VPD	MFn
11	A-10N	9.5	Whately A	0-3	PD	MCo
11	A-15N	14	Livingston A	0-3	VPD	Fn
11	A-28	26	Messena A	0-3	SPD	Med
11	A-3	3.5	Palms A	0-3	VPD	MFn
11	A-6	7	Livingston A	0-3	VPD	Fn
11	A-7	7	Empeyville B	3-8	MWD	MCo
11	A-7N	7	Carlisle A	0-3	VPD	MFn
11	A-8N	8	Livingston A	0-3	VPD	Fn
11	A-9	9.5	Palms A	0-3	VPD	MFn
11	A-9N	9.5	Panton A	0-3	MWD	Fn
11	AY-4	4.4	Covington A	0-3	PD	Fn
11	B-4	4	Messena A	0-3	SPD	Med
11	Beef Pstr	6	Muskelunge A	0-3	SPD	Fn
11	C-3	3	Amenia B	3-8	MWD	Med
11	C-6	7	Amenia B	3-8	MWD	Med
11	C-7	7	Messena B	3-8	SPD	Med
11	DB-6	6	Coveytown B	3-8	SPD	Co
11	P-2	1.5	Lyons A	0-3	PD	Med
11	P-20	20	Messena A	0-3	SPD	Med
11	R-12	13	Amenia B	3-8	MWD	Med
11	R-12NT	13	Messena A	0-3	SPD	Med
11	R-15	14	Covington A	0-3	PD	Fn
11	R-20E	7.5	Covington A	0-3	PD	Fn
11	R-20F	12	Whately A	0-3	PD	MCo
11	R-20W	18	Covington A	0-3	PD	Fn
11	R-38	37	Amenia B	3-8	MWD	Med
11	R-5N	5.5	Amenia B	3-8	MWD	Med
11	R-5NT	6.5	Amenia B	3-8	MWD	Med
11	R-5S	5.5	Amenia B	3-8	MWD	Med
11	R-6NT	7.5	Amenia B	3-8	MWD	Med
11	R-8NT	7.7	Messena A	0-3	SPD	Med
11	R-9	9	Panton A	0-3	MWD	Fn
11	RS-11N	9	Whately A	0-3	PD	MCo
11	RS-11S	11	Whately A	0-3	PD	MCo
11	RS-15	15	Briggs B	3-8	WD	MCo
11	RS-15-A	5	Messena A	0-3	SPD	Med
11	RS15-C	10	Briggs B	3-8	WD	MCo
12	ClearPc	45	Granby A	0-3	PD	Med
12	CloverPl	11	Granby A	0-3	PD	Med
12	Distefino	8	Madrid C	8-15	WD	Med
12	Drake	4	Fahey B	3-8	WD	Co
12	FarmRes	22	Fahey B	3-8	WD	Co
12	Frank'sPl	5	Granby A	0-3	PD	Med
12	Giroux	17	Adams A	0-3	ED	Co
12	GulleyPc	10	Adams A	0-3	ED	Co
12	Hassam	7	Nellis A	0-3	WD	Med
12	HenrichE	10	Plainfield A	0-3	ED	Med
12	HenrichW	20	Plainfield A	0-3	ED	Med
12	Kirby	16	Adams A	0-3	ED	Co

TABLE A-9. FIELD INFORMATION FOR THE SEVEN FARMS IN THE
ON-FARM PHOSPHORUS STUDY

CODE	FIELD	ACRES	SOIL TYPE	SLOPE	DRAINAGE	TEXTURE
12	Koeners	15	Madrid B	3-8	WD	Med
12	Pat's	35	Northway A	0-3	PD	Fn
12	Ruben	5	Adams A	0-3	ED	Co
12	SchweiktE	11	Northway A	0-3	PD	Fn
12	SchweiktW	9	Northway A	0-3	PD	Fn
12	SharronPl	30	GranbyA	0-3	PD	Med
12	SoperLow	12	Adams A	0-3	ED	Co
12	SoperUp	13	Adams A	0-3	ED	Co
12	Tim5	5	Fahey B	3-8	WD	Co
12	TimBorder	11	Coverfalls B	3-8	MWD	Fn
21	Acrs Barn	19	Limerick A	0-3	PD	Med
21	Back Laval	14	Adams A	0-3	ED	Co
21	Buses	25	Hadley A	0-3	WD	Med
21	Horse Barn	13.5	Belgrade B	3-8	MWD	Med
21	Interstate	25	Munson B	3-8	SPD	Med
21	Mid West	10	Hadley A	0-3	WD	Med
21	Murray	16	Enosburg B	3-8	PD	Co
21	Northwest	30	Hadley A	0-3	WD	Med
21	Powerline	5	Enosburg B	3-8	PD	Co
21	River	50	Hadley A	0-3	WD	Med
21	Rte117	19.5	Hadley A	0-3	WD	Med
21	Southwest	32	Hadley A	0-3	WD	Med
21	Tin Barn	25	Munson B	3-8	SPD	Med
21	ToolShed	10	Enosburg B	3-8	PD	Co
21	Top Hill	15	Belgrade B	3-8	MWD	Med
21	Underpass	18	Hadley A	0-3	WD	Med
21	WBunker	50	Hadley A	0-3	WD	Med

TABLE A-9. FIELD INFORMATION FOR THE SEVEN FARMS IN THE
ON-FARM PHOSPHORUS STUDY

CODE	FIELD	ACRES	SOIL TYPE	SLOPE	DRAINAGE	TEXTURE
22	01 rented	12	Tunbridge B	3-8	WD	MCo
22	01A-1B-1C	31.5	Stowe C	8-15	MWD	MCo
22	02 rented	12	Missisquoi A	0-3	ED	Co
22	03 rented	12	Missisquoi D	15-25	ED	Co
22	03A-02lowr	13	Peru B	3-8	MWD	MCo
22	03B-D	8	Peru B	3-8	MWD	MCo
22	05 front	6.7	Tunbridge C	8-15	WD	MCo
22	Bruner bck	11	Missisquoi A	0-3	ED	Co
22	Bruner frt	12	Hinesburg D	15-25	WD	Co
22	Eddy's	7.4	Westbury B	3-8	SPD	MCo
22	Wool1north	4	Deerfield B	3-8		Co
22	Wool2south	2	Missisquoi A	0-3	ED	Co
23	LH1	11.9	Binghamville A	0-3	PD	Med
23	LH10A	8	Scantic A	0-3	PD	Med
23	LH10B	16	Scantic A	0-3	PD	Med
23	LH10C	8	Scantic A	0-3	PD	Med
23	LH11	13.7	Covington A	0-3	PD	Fn
23	LH12	16.5	Binghamville A	0-3	PD	Med
23	LH2	7.5	Binghamville A	0-3	PD	Med
23	LH3	8	Binghamville A	0-3	PD	Med
23	LH4	10.3	Binghamville A	0-3	PD	Med
23	LH5	10.8	Binghamville A	0-3	PD	Med
23	LH6A	9.3	Binghamville A	0-3	PD	Med
23	LH6B	8.2	Binghamville A	0-3	PD	Med
23	LH7	16.5	Binghamville A	0-3	PD	Med
23	LH8	15.1	Georgia A	0-3	MWD	Med
23	LH9	14	Scantic A	0-3	PD	Med

TABLE A-9. FIELD INFORMATION FOR THE SEVEN FARMS IN THE
ON-FARM PHOSPHORUS STUDY

CODE	FIELD	ACRES	SOIL TYPE	SLOPE	DRAINAGE	TEXTURE
25	01J	30	Nellis B	3-8	WD	Med
25	02C	20	Covington A	0-3	PD	Fn
25	02HM	4.5	KendaiaA	0-3	MWD	MFn
25	02J	19	Covington A	0-3	PD	Fn
25	03AC	16	Covington A	0-3	PD	Fn
25	03C	30	Covington A	0-3	PD	Fn
25	03HM	1.8	Kendaia A	0-3	MWD	MFn
25	04	16	Covington A	0-3	PD	Fn
25	04AHM	15	Kendaia A	0-3	MWD	MFn
25	04HM	2.4	Kendaia B	3-8	MWD	MFn
25	05C	11.8	Covington A	0-3	PD	Fn
25	05HM	4.5	Kendaia A	0-3	MWD	MFn
25	06C	8.4	Kendaia A	0-3	MWD	MFn
25	06HM	16	Kendaia A	0-3	MWD	MFn
25	07	15	Covington A	0-3	PD	Fn
25	07C	6	Covington A	0-3	PD	Fn
25	07HM	3.8	Kendaia A	0-3	MWD	MFn
25	08C	5.8	Covington A	0-3	PD	Fn
25	09C	24.2	Covington A	0-3	PD	Fn
25	468	17.3	Amenia B	3-8	MWD	Med
25	7A	11	Kendaia A	0-3	MWD	MFn

TABLE A-9. FIELD INFORMATION FOR THE SEVEN FARMS IN THE
ON-FARM PHOSPHORUS STUDY

CODE	FIELD	ACRES	SOIL TYPE	SLOPE	DRAINAGE	TEXTURE
24	1	17	Messena A	0-3	SPD	Med
24	10	4.4	Georgia A	0-3	MWD	Med
24	11	8	Covington A	0-3	PD	Fn
24	12	6.8	Scantic A	0-3	PD	Med
24	13	7	Lyons A	0-3	PD	Med
24	14	3.7	Georgia A	0-3	MWD	Med
24	15	3	Georgia A	0-3	MWD	Med
24	16	16	Georgia A	0-3	MWD	Med
24	17	7.5	Messena A	0-3	SPD	Med
24	18	8.1	Messena A	0-3	SPD	Med
24	19	24	Birdsall A	0-3	VPD	Med
24	2	15.3	Scantic A	0-3	PD	Med
24	20	19.2	Birdsall A	0-3	VPD	Med
24	3	8	Scantic A	0-3	PD	Med
24	5	4.1	Messena A	0-3	SPD	Med
24	6	20	Covington A	0-3	PD	Fn
24	7	13.8	Scantic A	0-3	PD	Med
24	8	12.2	Binghamville A	0-3	PD	Med
24	9	18.7	Scantic A	0-3	PD	Med

TABLE A-10. FERTILIZER INFORMATION FOR THE SEVEN FARMS IN THE ON-FARM PHOSPHORUS STUDY

FARM CODE	FIELD	DATE	TYPE	NIT	----- LB / A -----		K2O	TYPE	NIT	----- TOT LB / DATE -----	
					P2O5	P2O5				P2O5	K2O
11	A-10	05/08/95	Chemical	13	32	32	48	None	149.5	368	552
11	A-10	06/22/95	Chemical	110	0	0	0	None	1265	0	0
11	A-10N	05/06/95	Chemical	13	32	32	48	None	123.5	304	456
11	A-10N	06/23/95	Chemical	60	0	0	0	None	570	0	0
11	A-8N	10/20/94	Chemical	36	70	70	105	None	288	560	840
11	A-9N	05/06/95	Chemical	13	32	32	48	None	123.5	304	456
11	A-9N	06/23/95	Chemical	60	0	0	0	None	570	0	0
11	AY-4	05/02/95	Chemical	13	32	32	48	None	57.2	140.8	211.2
11	AY-4	06/19/95	Chemical	60	0	0	0	None	264	0	0
11	P-20	05/10/95	Chemical	24	60	60	90	None	480	1200	1800
11	P-20	06/21/95	Chemical	75	0	0	0	None	1500	0	0
11	R-12	05/02/95	Chemical	13	32	32	48	None	169	416	624
11	R-12	06/19/95	Chemical	100	0	0	0	None	1300	0	0
11	R-15	05/04/95	Chemical	13	32	32	48	None	182	448	672
11	R-15	06/28/95	Chemical	80	0	0	0	None	1120	0	0
11	R-20F	05/03/95	Chemical	13	32	32	48	None	156	384	576
11	R-20F	06/21/95	Chemical	75	0	0	0	None	900	0	0
11	R-20W	05/03/95	Chemical	13	32	32	48	None	234	576	864
11	R-20W	06/20/95	Chemical	80	0	0	0	None	1440	0	0
11	R-38	06/06/95	Chemical	0	0	0	180	None	0	0	6660
11	R-9	06/17/95	Chemical	0	0	0	120	None	0	0	1080
11	RS-11N	05/04/95	Chemical	13	32	32	48	None	117	288	432
11	RS-11N	06/21/95	Chemical	55	0	0	0	None	495	0	0
11	RS-11S	06/17/95	Chemical	0	0	0	120	None	0	0	1320
11	RS-15-A	06/17/95	Chemical	0	0	0	120	None	0	0	600
11	RS15-C	05/04/95	Chemical	13	32	32	48	None	130	320	480
11	A-15N	06/15/95	Manure	65	45	45	85	Slurry	910	630	1190
11	A-28	07/14/95	Manure	80	55	55	100	Slurry	2080	1430	2600
11	A-3	07/15/95	Manure	115	80	80	140	Slurry	402.5	280	490
11	A-6	07/15/95	Manure	80	65	65	140	Slurry	560	455	980
11	A-6	07/16/95	Manure	155	110	110	190	Compost	1085	770	1330
11	A-7	11/20/94	Manure	85	55	55	105	Slurry	595	385	735
11	A-7	08/01/95	Manure	175	120	120	220	Slurry	1225	840	1540
11	A-7N	06/26/95	Manure	125	85	85	155	Slurry	875	595	1085
11	A-9	07/15/95	Manure	185	130	130	230	Slurry	1757.5	1235	2185
11	A-9N	10/01/94	Manure	65	50	50	100	Slurry	617.5	475	950
11	DB-6	11/20/94	Manure	80	55	55	105	Slurry	480	330	630

TABLE A-10. FERTILIZER INFORMATION FOR THE SEVEN FARMS IN THE ON-FARM PHOSPHORUS STUDY

FARM CODE	FIELD	DATE	TYPE	NIT	----- LB / A -----		K2O	MANURE		NIT	----- TOT LB / DATE -----	
					P2O5			TYPE			P2O5	K2O
11	R-12	10/08/94	Manure	11	11		22	Solid		143	143	286
11	R-12NT	08/11/95	Manure	50	35		65	Slurry		650	455	845
11	R-20E	11/20/94	Manure	110	75		140	Slurry		825	562.5	1050
11	R-5N	10/04/94	Manure	90	60		110	Slurry		495	330	605
11	R-5N	06/28/95	Manure	250	210		450	Compost		1375	1155	2475
11	R-5NT	08/14/95	Manure	70	50		90	Slurry		455	325	585
11	R-5S	10/04/94	Manure	90	60		110	Slurry		495	330	605
11	R-5S	06/26/95	Manure	250	210		450	Compost		1375	1155	2475
11	R-6NT	08/14/95	Manure	50	35		65	Slurry		375	262.5	487.5
11	R-8NT	08/14/95	Manure	70	50		90	Slurry		539	385	693
11	RS-11N	10/05/94	Manure	100	65		120	Slurry		900	585	1080
11	RS-15	10/10/94	Manure	160	160		320	Slurry		2400	2400	4800
12	ClearPc	05/15/95	Chemical	47.4	18.96		28.44	None		2133	853.2	1279.8
12	CloverPl	05/15/95	Chemical	47.4	18.96		28.44	None		521.4	208.56	312.84
12	Giroux	07/04/95	Chemical	0	0		72	None		0	0	1224
12	Hassam	07/04/95	Chemical	0	0		72	None		0	0	504
12	HenrichE	07/04/95	Chemical	0	0		72	None		0	0	720
12	Kirby	07/04/95	Chemical	0	0		72	None		0	0	1152
12	Pat's	05/15/95	Chemical	51.48	51.48		51.48	None		1801.8	1801.8	1801.8
12	SharonPl	05/15/95	Chemical	47.4	18.96		28.44	None		1422	568.8	853.2
12	SoperUp	05/15/95	Chemical	47.4	18.96		28.44	None		616.2	246.48	369.72
12	ClearPc	06/01/95	Manure	316	132		251	Solid		14220	5940	11295
12	CloverPl	06/01/95	Manure	316	132		251	Solid		3476	1452	2761
12	Drake	06/01/95	Manure	165	69		131	Solid		660	276	524
12	FarmRes	06/01/95	Manure	316	132		250.9	Solid		6952	2904	5519.8
12	Frank'sPl	06/01/95	Manure	316	69		251	Solid		1580	345	1255
12	Giroux	06/01/95	Manure	165	69		131	Solid		2805	1173	2227
12	GulleyPc	06/01/95	Manure	316	133		251	Solid		3160	1330	2510
12	Hassam	06/01/95	Manure	165	69		131	Solid		1155	483	917
12	Kirby	06/01/95	Manure	165	69		131	Solid		2640	1104	2096
12	Ruben	06/01/95	Manure	165	69		131	Solid		825	345	655
12	SchweiktE	06/01/95	Manure	165	69		131	Solid		1815	759	1441
12	SchweiktW	06/01/95	Manure	165	69		131	Solid		1485	621	1179
12	SharonPl	06/01/95	Manure	316	132		251	Solid		9480	3960	7530
12	SoperLow	06/01/95	Manure	316	132		251	Solid		3792	1584	3012
12	SoperUp	06/01/95	Manure	316	132		251	Solid		4108	1716	3263
12	Tim5	06/01/95	Manure	316	132		251	Solid		1580	660	1255

TABLE A-10. FERTILIZER INFORMATION FOR THE SEVEN FARMS IN THE ON-FARM PHOSPHORUS STUDY

FARM CODE	FIELD	DATE	TYPE	MANURE				TOT LB / A			
				NIT	P2O5	K2O	TYPE	NIT	P2O5	K2O	DATE
12	TimBorder	06/01/95	Manure	316	132	251	Solid	3476	1452	2761	
21	Acrs Barn	05/25/95	Chemical	0	0	60	None	0	0	1140	
21	Acrs Barn	05/31/95	Chemical	20	68	0	None	380	1292	0	
21	Acrs Barn	07/01/95	Chemical	46	0	0	None	874	0	0	
21	Back Laval	04/27/95	Chemical	0	0	180	None	0	0	2520	
21	Buses	05/06/95	Chemical	0	0	144	None	0	0	3600	
21	Buses	05/07/95	Chemical	4.4	20.8	0	None	110	520	0	
21	Horse Barn	05/25/95	Chemical	0	0	199.8	None	0	0	2697.3	
21	Horse Barn	06/01/95	Chemical	28	95.2	0	None	378	1285.2	0	
21	Horse Barn	07/12/95	Chemical	115	0	0	None	1552.5	0	0	
21	Interstate	04/26/95	Chemical	0	0	120	None	0	0	3000	
21	Interstate	05/05/95	Chemical	0	0	120	None	0	0	3000	
21	Mid West	05/06/95	Chemical	0	0	60	None	0	0	600	
21	Mid West	06/30/95	Chemical	103.5	0	0	None	1035	0	0	
21	Northwest	05/06/95	Chemical	0	0	165	None	0	0	4950	
21	Northwest	05/12/95	Chemical	20	68	0	None	600	2040	0	
21	Northwest	06/30/95	Chemical	103.5	0	0	None	3105	0	0	
21	Powerline	04/28/95	Chemical	0	0	135	None	0	0	675	
21	Powerline	04/29/95	Chemical	30.82	0	0	None	154.1	0	0	
21	Powerline	04/30/95	Chemical	5.5	26	0	None	27.5	130	0	
21	River	06/13/95	Chemical	50.6	0	0	None	2530	0	0	
21	Rte117	06/02/95	Chemical	0	0	60	None	0	0	1170	
21	Rte117	07/01/95	Chemical	92	0	0	None	1794	0	0	
21	Southwest	05/06/95	Chemical	0	0	60	None	0	0	1920	
21	Southwest	06/30/95	Chemical	103.5	0	0	None	3312	0	0	
21	Tin Barn	04/27/95	Chemical	0	0	120	None	0	0	3000	
21	ToolShed	04/28/95	Chemical	0	0	139.8	None	0	0	1398	
21	ToolShed	04/29/95	Chemical	30.82	0	0	None	308.2	0	0	
21	ToolShed	04/30/95	Chemical	5.5	26	0	None	55	260	0	
21	ToolShed	07/05/95	Chemical	80.5	0	0	None	805	0	0	
21	Top Hill	04/27/95	Chemical	0	0	120	None	0	0	1800	
21	Top Hill	04/28/95	Chemical	46	0	0	None	690	0	0	
21	Underpass	04/26/95	Chemical	0	0	120	None	0	0	2160	
21	WBunker	07/01/95	Chemical	69	0	0	None	3450	0	0	
21	Acrs Barn	05/24/95	Manure	202.3	104.3	178.5	Slurry	3843.7	1981.7	3391.5	
21	Buses	07/23/95	Manure	173.4	89.4	153	Slurry	4335	2235	3825	
21	Interstate	07/25/95	Manure	173.4	89.4	153	Slurry	4335	2235	3825	

TABLE A-10. FERTILIZER INFORMATION FOR THE SEVEN FARMS IN THE ON-FARM PHOSPHORUS STUDY

FARM CODE	FIELD	DATE	TYPE	NIT	----- LB / A -----		K2O	TYPE	----- TOT LB / DATE -----	
					P2O5	NIT			P2O5	K2O
21	Mid West	05/05/95	Manure	115.6	59.6	1156	102	Slurry	596	1020
21	Rte117	05/24/95	Manure	144.5	74.5	2817.75	127.5	Slurry	1452.75	2486.25
21	Southwest	05/05/95	Manure	115.6	59.6	3699.2	102	Slurry	1907.2	3264
21	Tin Barn	07/27/95	Manure	173.4	89.4	4335	153	Slurry	2235	3825
21	Underpass	07/26/95	Manure	173.4	89.4	3121.2	153	Slurry	1609.2	2754
21	WBunker	05/10/95	Manure	231.2	119.2	11560	204	Slurry	5960	10200
22	01 rented	07/08/95	Chemical	30	0	360	20	None	0	240
22	01 rented	08/03/95	Chemical	27.6	0	331.2	0	None	0	0
22	01A-1B-1C	07/15/95	Chemical	23	0	724.5	30	None	0	945
22	01A-1B-1C	08/05/95	Chemical	18.4	0	579.6	24	None	0	756
22	02 rented	07/08/95	Chemical	30	0	360	20	None	0	240
22	03 rented	08/31/95	Chemical	34.5	0	414	34.5	None	0	414
22	03A-02lowr	07/10/95	Chemical	30	0	390	20	None	0	260
22	03A-02lowr	08/31/95	Chemical	30	0	390	20	None	0	260
22	03B-D	07/10/95	Chemical	23	0	184	30	None	0	240
22	05 front	08/31/95	Chemical	30	0	201	20	None	0	134
22	Bruner bck	08/31/95	Chemical	34.5	0	379.5	34.5	None	0	379.5
22	Bruner frt	08/31/95	Chemical	34.5	0	414	34.5	None	0	414
22	Eddy's	08/31/95	Chemical	34.5	0	255.3	34.5	None	0	255.3
22	WoolInorth	07/08/95	Chemical	27.6	0	110.4	0	None	0	0
22	WoolInorth	08/31/95	Chemical	34.5	0	138	34.5	None	0	138
22	01 rented	07/10/95	Manure	15	31	180	53	Liquid	372	636
22	01A-1B-1C	08/06/95	Manure	4	11	126	19	Liquid	346.5	598.5
22	02 rented	05/06/95	Manure	14	29	168	49	Liquid	348	588
22	03B-D	06/25/95	Manure	15	39	120	66	Liquid	312	528
22	03B-D	10/20/95	Manure	14	35	112	59	Liquid	280	472
22	05 front	10/20/95	Manure	20	40	134	68	Liquid	268	455.6
22	Eddy's	10/20/95	Manure	13	44	96.2	74	Liquid	325.6	547.6
22	WoolInorth	04/28/95	Manure	13	34	57	57	Liquid	136	228
23	LH1	04/01/95	Chemical	46	0	547.4	0	None	0	0
23	LH1	04/02/95	Chemical	0	0	0	72	None	0	856.8
23	LH10A	06/10/95	Chemical	46	0	368	0	None	0	0
23	LH10B	04/01/95	Chemical	46	0	736	0	None	0	0
23	LH11	06/10/95	Chemical	46	0	630.2	0	None	0	0
23	LH12	06/25/95	Chemical	46	0	759	0	None	0	0
23	LH2	06/25/95	Chemical	46	0	345	0	None	0	0
23	LH3	06/25/95	Chemical	46	0	368	0	None	0	0

TABLE A-10. FERTILIZER INFORMATION FOR THE SEVEN FARMS IN THE ON-FARM PHOSPHORUS STUDY

FARM CODE	FIELD	DATE	TYPE	NIT	----- LB / A -----		K2O	MANURE		NIT	----- TOT LB / DATE -----	
					P2O5	LB / A		TYPE	K2O		P2O5	K2O
23	LH4	04/01/95	Chemical	0	0	0	138	None	0	0	0	1421.4
23	LH4	04/02/95	Chemical	55.2	0	0	0	None	568.56	0	0	0
23	LH5	04/01/95	Chemical	0	0	0	132	None	0	0	0	1425.6
23	LH5	04/02/95	Chemical	23	0	0	0	None	248.4	0	0	0
23	LH6A	04/01/95	Chemical	46	0	0	0	None	427.8	0	0	0
23	LH6B	04/01/95	Chemical	46	0	0	0	None	377.2	0	0	0
23	LH6B	04/02/95	Chemical	0	0	0	60	None	0	0	0	492
23	LH8	04/01/95	Chemical	46	0	0	0	None	694.6	0	0	0
23	LH8	04/02/95	Chemical	0	0	0	68	None	0	0	0	1026.8
23	LH9	04/01/95	Chemical	46	0	0	0	None	644	0	0	0
23	LH9	04/02/95	Chemical	0	0	0	60	None	0	0	0	840
23	LH1	07/10/95	Manure	26	45	45	79	Liquid	309.4	535.5	940.1	
23	LH10B	07/10/95	Manure	26	45	45	79	Liquid	416	720	1264	
23	LH10C	07/10/95	Manure	26	45	45	79	Liquid	208	360	632	
23	LH11	05/01/95	Manure	26	45	45	79	Liquid	356.2	616.5	1082.3	
23	LH12	05/01/95	Manure	91	90	90	158	Liquid	1501.5	1485	2607	
23	LH2	05/01/95	Manure	91	90	90	158	Liquid	682.5	675	1185	
23	LH3	05/01/95	Manure	91	90	90	158	Liquid	728	720	1264	
23	LH4	07/26/95	Manure	26	45	45	79	Liquid	267.8	463.5	813.7	
23	LH5	07/26/95	Manure	26	45	45	79	Liquid	280.8	486	853.2	
23	LH6A	07/10/95	Manure	26	45	45	79	Liquid	241.8	418.5	734.7	
23	LH6B	07/10/95	Manure	26	45	45	79	Liquid	213.2	369	647.8	
23	LH7	05/01/95	Manure	45	45	45	79	Liquid	742.5	742.5	1303.5	
23	LH8	07/10/95	Manure	26	45	45	79	Liquid	392.6	679.5	1192.9	
23	LH9	07/10/95	Manure	26	45	45	79	Liquid	364	630	1106	
24	1	05/14/95	Chemical	28	56	56	28	None	476	952	476	
24	11	05/15/95	Chemical	45	24	24	36	None	360	192	288	
24	12	05/15/95	Chemical	45	24	24	36	None	306	163.2	244.8	
24	13	05/15/95	Chemical	45	24	24	36	None	315	168	252	
24	15	05/15/95	Chemical	0	30	30	90	None	0	90	270	
24	17	05/15/95	Chemical	0	30	30	90	None	0	225	675	
24	18	05/15/95	Chemical	0	30	30	90	None	0	243	729	
24	19	05/15/95	Chemical	0	30	30	90	None	0	720	2160	
24	2	05/15/95	Chemical	15	15	15	15	None	229.5	229.5	229.5	
24	20	05/15/95	Chemical	15	15	15	15	None	288	288	288	
24	3	05/14/95	Chemical	28	56	56	28	None	224	448	224	
24	5	05/15/95	Chemical	0	30	30	90	None	0	123	369	

TABLE A-10. FERTILIZER INFORMATION FOR THE SEVEN FARMS IN THE ON-FARM PHOSPHORUS STUDY

FARM CODE	FIELD	DATE	TYPE	NIT	LB / A		K2O	MANURE		NIT	P2O5	K2O
												TOT LB / DATE
24	5	07/15/95	Chemical	89.12	36.67	82.49	None	365.392	150.347	338.209		
24	6	05/05/95	Chemical	28	56	28	Liquid	560	1120	560		
24	7	05/15/95	Chemical	0	30	90	None	0	414	1242		
24	8	05/14/95	Chemical	28	56	28	None	341.6	683.2	341.6		
24	9	05/06/95	Chemical	28	56	28	None	523.6	1047.2	523.6		
24	1	04/27/95	Manure	192.31	79.11	177.99	Liquid	3269.27	1344.87	3025.83		
24	11	04/28/95	Manure	78.96	32.48	73.08	Liquid	631.68	259.84	584.64		
24	12	04/28/95	Manure	79.62	32.75	73.69	Liquid	541.416	222.7	501.092		
24	16	07/10/95	Manure	84.6	34.8	78.3	Liquid	1353.6	556.8	1252.8		
24	17	07/14/95	Manure	84.22	34.65	77.95	Liquid	631.65	259.875	584.625		
24	18	07/15/95	Manure	89.12	36.67	82.49	Liquid	721.872	297.027	668.169		
24	19	06/22/95	Manure	75.2	30.93	69.6	Liquid	1804.8	742.32	1670.4		
24	3	04/27/95	Manure	192.31	79.11	177.99	Liquid	1538.48	632.88	1423.92		
24	6	04/19/95	Manure	180.48	74.24	167.04	None	3609.6	1484.8	3340.8		
24	7	06/20/95	Manure	78.47	32.28	72.62	Liquid	1082.88	445.464	1002.156		
24	8	04/27/95	Manure	192.31	79.11	177.99	Liquid	2346.18	965.142	2171.478		
24	9	04/25/95	Manure	120.64	49.63	111.65	Liquid	2255.96	928.081	2087.855		
25	02C	05/13/95	Chemical	38	38	38	None	760	760	760		
25	02HM	05/22/95	Chemical	36	36	36	None	162	162	162		
25	02J	05/26/95	Chemical	10	20	20	None	190	380	380		
25	03AC	05/26/95	Chemical	20	20	40	None	320	320	640		
25	03C	05/01/95	Chemical	10	16	35	None	300	480	1050		
25	04AHM	05/23/95	Chemical	15	15	30	None	225	225	450		
25	05HM	05/08/95	Chemical	31	31	22	None	139.5	139.5	99		
25	07C	05/14/95	Chemical	19	19	19	None	114	114	114		
25	07HM	05/08/95	Chemical	31	31	22	None	117.8	117.8	83.6		
25	08C	05/13/95	Chemical	44	44	32	None	255.2	255.2	185.6		
25	09C	05/09/95	Chemical	44	44	32	None	1064.8	1064.8	774.4		
25	06C	09/16/95	Manure	72	79.5	117	Solid	604.8	667.8	982.8		
25	07	05/10/95	Manure	36	39.75	58.5	Solid	540	596.25	877.5		
25	07	09/11/95	Manure	36	39.75	58.5	Solid	540	596.25	877.5		
25	07C	05/10/95	Manure	16.8	18.55	27.3	Solid	100.8	111.3	163.8		
25	07C	09/11/95	Manure	16.8	18.55	27.3	Solid	100.8	111.3	163.8		
25	7A	05/10/95	Manure	36	39.75	58.5	Solid	396	437.25	643.5		

TABLE A-10. FERTILIZER INFORMATION FOR THE SEVEN FARMS IN THE ON-FARM PHOSPHORUS STUDY

FARM CODE	FIELD	DATE	TYPE	NIT	MANURE			NIT	TOT LB / DATE----		
					P2O5	K2O	TYPE		-----	P2O5	K2O
25	7A	09/11/95	Manure	36	39.75	58.5	Solid	396	-----	437.25	643.5

TABLE A-11. PLANTING INFORMATION FOR THE SEVEN FARMS IN THE
ON-FARM PHOSPHORUS STUDY

Code	Field Id	CROP	Plant Date	PH	P-test	K-Test
----- lb / A -----						
11	A-10	Corn	05/08/95	6.6	10	115
11	A-10N	Corn	05/06/95	6.8	6	110
11	A-15N	Grass Est	06/02/93	6.8	6	155
11	A-28	Alf Est		6.7	13	100
11	A-3	Grass Est		6.9	15	180
11	A-6	Rye	10/03/94	6.6	7	105
11	A-7	Grass Est		6.4	14	325
11	A-7N	Grass Est		7.3	10	255
11	A-8N	Alf Est	06/18/93	6.7	9	95
11	A-9	Grass Est	08/02/93	6.3	9	240
11	A-9N	Corn	05/06/95	6.8	6	110
11	AY-4	Corn	05/02/95	7	67	215
11	B-4	Grass Est	05/25/93	7.9	1	65
11	Beef Pstr	Grass Est				
11	C-3	Grass Est		6.9	12	205
11	C-6	Grass Est		6.9	5	145
11	C-7	Grass Est		7.3	7	155
11	DB-6	Grass Est		6.7	14	110
11	P-2	Grass Est	07/20/94	6.5	1	55
11	P-20	Corn	05/10/95	6.4	1	95
11	R-12	Corn	05/02/95	6.6	25	275
11	R-12NT	Alf Est	05/27/93	7.6	205	425
11	R-15	Corn	05/04/95	6.7	5	140
11	R-20E	Grass Est		7.1	15	110
11	R-20F	Corn	05/03/95	7.3	9	100
11	R-20W	Corn	05/03/95	6.6	24	210
11	R-38	Alf Est	05/06/94	7.2	23	145
11	R-38	Rye	05/15/95			
11	R-5N	Rye	10/07/94	6.8	21	185
11	R-5NT	Alf Est	05/27/93	7.5	81	190
11	R-5S	Rye	10/05/94	6.8	21	185
11	R-6NT	Alf Est		7.4	76	235
11	R-8NT	Alf Est		7.7	65	160
11	R-9	Alf Est	07/25/94	7.2	9	165
11	RS-11N	Corn	05/04/95	6.9	4	160
11	RS-11N	Grass Est				
11	RS-11S	Alf Est	05/23/93	7.5	17	140
11	RS-11S	Alf sdg	08/12/94			
11	RS-15-A	Alf Est		7.3	18	140
11	RS15-C	Corn	05/04/95	7.3	18	140
12	ClearPc	Corn	05/15/95	7.4		
12	CloverPl	Corn	05/15/95	7		
12	Distefino	Grass Est				
12	Drake	Alf Est	08/01/92	7	226	995
12	FarmRes	Alf Est	08/01/93	7	8	125
12	Frank'sPl	Alf Est	08/01/93			
12	Giroux	Alf Est	08/01/92	7	8	125
12	GulleyPc	Alf/Grs Es		7.1	15	120
12	Hassam	Alf Est	08/01/92	6.8	13	165
12	HenrichE	Alf Est	08/01/94	7	16	135
12	HenrichW	Grass Est		6.2	2	90

TABLE A-11. PLANTING INFORMATION FOR THE SEVEN FARMS IN THE
ON-FARM PHOSPHORUS STUDY

Code	Field Id	CROP	Plant Date	PH	P-test	K-Test
					----- lb / A -----	
12	Kirby	Alf Est	08/01/94	6.7	1	115
12	Koeners	Grass Est				
12	Pat's	Corn	05/15/95	6.5		
12	Ruben	Alf Est	08/01/92	7.4	390	990
12	SchweiktE	Grass Est		7.3	7	70
12	SchweiktW	Grass Est		7.3	7	70
12	SharronPl	Corn	05/15/95	7	83	123
12	SoperLow	Alf Est	08/01/92	6.7	29	160
12	SoperUp	Corn	05/15/95	6.7	29	160
12	Tim5	Grass Est		6.7	11	300
12	TimBorder	Alf sdg	08/01/95	7	143	248
21	Acrs Barn	Corn	05/31/95	6.9	7	58
21	Back Laval	Alf/Grs Es	05/01/91	7.1	96	196
21	Buses	Alf/Grs Es	05/01/93	7.1	26	108
21	Horse Barn	Corn	06/04/95	7	2	80
21	Interstate	Alf/Grs Es	05/01/93	7.3	15	180
21	Mid West	Corn	05/11/95	6.5	22	174
21	Murray	Clv/Grs Es		6.6	0	48
21	Northwest	Corn	05/19/95	5.9	6	64
21	Powerline	Clv/Grs Es		6.5	0	54
21	River	Alf/Grs sd	04/30/94	6.8	49	152
21	Rte117	Corn	06/03/95	5.3	12	122
21	Southwest	Corn	05/12/95	6.2	30	124
21	Tin Barn	Alf/Grs Es	05/01/92	6.9	14	220
21	ToolShed	Clv/Grs Es		7.2	54	96
21	Top Hill	Alf/Grs Es		7.1	10	72
21	Underpass	Alf/Grs Es	05/01/92	7	7	96
21	WBunker	Corn	05/10/95	7.1	46	200
22	01 rented	Grass Est				
22	01A-1B-1C	Grass Est				
22	02 rented	Grass Est				
22	03 rented	Grass Est				
22	03A-02lowr	Grass Est				
22	03B-D	Grass Est				
22	05 front	Grass Est				
22	Bruner bck	Grass Est				
22	Bruner frt	Grass Est				
22	Eddy's	Grass Est				
22	Wool1north	Grass Est				
22	Wool2south	Grass Est				
23	LH1	Grass Est		7		
23	LH10A	Pasture		7		
23	LH10B	Grass Est		6.7		
23	LH10C	Pasture		6.3		
23	LH11	Pasture				
23	LH12	Corn	05/01/95	8		
23	LH2	Corn	05/01/95	7.4		
23	LH3	Corn	05/01/95	6.8		
23	LH4	Clv/Grs Es		7		
23	LH5	Clv/Grs sd		6.7		
23	LH6A	Grass Est		6.9		

TABLE A-11. PLANTING INFORMATION FOR THE SEVEN FARMS IN THE
ON-FARM PHOSPHORUS STUDY

Code	Field Id	CROP	Plant Date	PH	P-test	K-Test
----- lb / A -----						
23	LH6B	Grass Est		6.4		
23	LH7	Corn	05/01/95	7.4		
23	LH8	Grass Est		6.2		
23	LH9	Grass Est		6.8		
24	1	Corn	05/14/95			
24	11	Alf/Grs Es		7.1		
24	12	Pasture		7.2		
24	13	Pasture		6.9		
24	15	Alf sdg	05/17/95	6.4		
24	16	Alf/Grs Es	05/15/93	6.7		
24	17	Alf/Grs Es	05/15/93	7.4		
24	18	Alf/Grs Es	05/15/93			
24	19	Alf/Grs Es	05/15/95	6.7		
24	2	Grass Est	05/14/93			
24	20	Grass Est	05/14/93			
24	3	Corn	05/14/95			
24	5	Alf/Grs Es	05/14/93			
24	6	Corn	05/10/95	7		
24	7	Alf/Grs Es	05/15/92	6.7		
24	8	Corn	05/14/95	6.8		
24	9	Corn	05/05/95	7.7		
25	01J	Alf/Grs Es				
25	02C	Corn	05/13/95	7.3	13	219
25	02HM	Corn	05/08/95	7		
25	02J	Soybeans	05/26/95			
25	03AC	Soybeans	05/26/95	6.9	8	112
25	03C	Oat/Barley	05/04/95			
25	03HM	Oat/Barley	05/04/95			
25	04	Grass Est				
25	04AHM	Soybeans	05/23/95	6.9	11	82
25	04HM	Pasture				
25	05C	Grass Est				
25	05HM	Corn	05/08/95	7.5	30	153
25	06C	Clv/Grs Es				
25	06HM	Alf/Grs Es		7.2	13	184
25	07	Alf/Grs Es				
25	07C	Corn	05/14/95			
25	07HM	Corn	05/08/95	7.1	7	202
25	08C	Corn	05/13/95	6.8	5	181
25	09C	Corn	05/09/95	7.2		
25	468	Oat/Barley				
25	7A	Grass Est				

TABLE A-12. HARVEST INFORMATION FOR THE SEVEN FARMS IN THE ON-FARM PHOSPHORUS STUDY

FARM CODE	FIELD	CROP	HARVEST DATE	HARVEST AS	STORAGE	NIT ^a	----- TONS / DATE -----			
							P	K	DM	
11	A-10	Corn	09/12/95	CornSilage	Silo, bunker	0.78	0.15	0.70	61.12	
11	A-10N	Corn	09/11/95	CornSilage	Silo, bunker	0.65	0.13	0.59	51.01	
11	A-9N	Corn	09/10/95	CornSilage	Silo, bunker	0.69	0.13	0.62	53.70	
11	AY-4	Corn	08/29/95	CornSilage	Silo, bunker	0.03	0.01	0.03	2.52	
11	AY-4	Corn	09/06/95	CornSilage	Silo, bunker	0.29	0.06	0.26	22.78	
11	P-20	Corn	09/12/95	CornSilage	Silo, bunker	0.12	0.02	0.11	9.60	
11	R-12	Corn	08/29/95	CornSilage	Silo, bunker	0.10	0.02	0.09	7.50	
11	R-12	Corn	09/05/95	CornSilage	Silo, bunker	0.75	0.15	0.67	58.41	
11	R-15	Corn	08/29/95	CornSilage	Silo, bunker	0.13	0.03	0.12	10.08	
11	R-15	Corn	09/05/95	CornSilage	Silo, bunker	0.81	0.16	0.72	63.04	
11	R-20F	Corn	08/29/95	CornSilage	Silo, bunker	0.03	0.01	0.03	2.52	
11	R-20F	Corn	09/09/95	CornSilage	Silo, bunker	0.91	0.18	0.82	71.40	
11	R-20W	Corn	08/29/95	CornSilage	Silo, bunker	0.03	0.01	0.03	2.52	
11	R-20W	Corn	09/07/95	CornSilage	Silo, bunker	1.00	0.20	0.90	78.20	
11	RS-11N	Corn	09/11/95	CornSilage	Silo, bunker	0.70	0.14	0.63	54.40	
11	RS15-C	Corn	08/13/95	CornSilage	Silo, bunker	0.79	0.15	0.71	61.80	
11	A-15N	Grass Est	06/07/95	Hay-G	Small bale, inside	0.25	0.04	0.25	12.63	
11	A-15N	Grass Est	08/23/95	Hay-G	Small bale, inside	0.14	0.02	0.14	7.08	
11	A-7	Grass Est	06/13/95	Hay-G	Small bale, inside	0.21	0.03	0.21	10.56	
11	A-7N	Grass Est	08/16/95	Hay-G	Small bale, inside	0.06	0.01	0.06	3.00	
11	A-9	Grass Est	06/12/95	Hay-G	Small bale, inside	0.08	0.01	0.08	4.05	
11	A-9	Grass Est	08/29/95	Hay-G	Small bale, inside	0.10	0.02	0.10	4.84	
11	B-4	Grass Est	06/18/95	Hay-G	Small bale, inside	0.06	0.01	0.07	3.26	
11	B-4	Grass Est	08/21/95	Hay-G	Small bale, inside	0.03	0.01	0.04	1.76	
11	Beef Pstr	Grass Est	06/13/95	Hay-G	Small bale, inside	0.19	0.03	0.19	9.42	
11	C-3	Grass Est	06/19/95	Hay-G	Small bale, inside	0.10	0.02	0.10	5.10	
11	C-3	Grass Est	08/16/95	Hay-G	Small bale, inside	0.01	0.00	0.01	0.70	
11	C-6	Grass Est	06/18/95	Hay-G	Small bale, inside	0.21	0.03	0.21	10.56	
11	C-7	Grass Est	06/19/95	Hay-G	Small bale, inside	0.17	0.03	0.17	8.62	
11	DB-6	Grass Est	06/26/95	Hay-G	Small bale, inside	0.22	0.04	0.23	11.35	
11	DB-6	Grass Est	08/22/95	Hay-G	Small bale, inside	0.06	0.01	0.06	2.90	
11	R-20E	Grass Est	06/17/95	Hay-G	Small bale, inside	0.21	0.03	0.22	10.74	

^a NIT = NITROGEN, P = PHOSPHORUS, AND K = POTASSIUM, DM = DRY MATTER.

TABLE A-12. HARVEST INFORMATION FOR THE SEVEN FARMS IN THE ON-FARM PHOSPHORUS STUDY

FARM CODE	FIELD	CROP	HARVEST DATE	HARVEST AS	STORAGE	NIT ^a	TONS / DATE			
							P	K	DM	
11	RS-11N	Grass Est	06/23/95	Hay-G	Small bale, inside	0.06	0.01	0.07	3.26	
11	RS-11N	Grass Est	08/21/95	Hay-G	Small bale, inside	0.01	0.00	0.01	0.62	
11	A-28	Alf Est	06/16/95	Hay-L	Small bale, inside	0.14	0.01	0.12	4.95	
11	A-3	Grass Est	06/09/95	HCS-G	Silo, bunker	0.12	0.02	0.12	5.22	
11	A-7N	Grass Est	06/09/95	HCS-G	Silo, bunker	0.30	0.05	0.31	13.26	
11	A-9	Grass Est	06/13/95	HCS-G	Silo, bunker	0.29	0.04	0.30	12.92	
11	A-9	Grass Est	08/28/95	HCS-G	Silo, bunker	0.25	0.04	0.26	11.26	
11	P-2	Grass Est	06/01/95	HCS-G	Silo, bunker	0.04	0.01	0.05	2.00	
11	P-2	Grass Est	07/31/95	HCS-G	Silo, bunker	-0.00	0.00	0.00	0.18	
11	A-28	Alf Est	05/30/95	HCS-L	Silo, bunker	1.04	0.11	0.87	33.09	
11	A-28	Alf Est	07/03/95	HCS-L	Silo, bunker	0.54	0.06	0.45	17.16	
11	A-28	Alf Est	08/07/95	HCS-L	Silo, bunker	0.35	0.04	0.30	11.21	
11	A-8N	Alf Est	05/31/95	HCS-L	Silo, bunker	0.47	0.05	0.40	15.15	
11	R-12NT	Alf Est	06/05/95	HCS-L	Silo, bunker	0.53	0.06	0.44	16.80	
11	R-12NT	Alf Est	07/06/95	HCS-L	Silo, bunker	0.17	0.02	0.14	5.44	
11	R-12NT	Alf Est	08/09/95	HCS-L	Silo, bunker	0.23	0.02	0.19	7.32	
11	R-38	Alf Est	05/31/95	HCS-L	Silo, bunker	1.45	0.16	1.22	46.19	
11	R-38	Alf Est	07/03/95	HCS-L	Silo, bunker	0.70	0.08	0.59	22.44	
11	R-38	Alf Est	08/08/95	HCS-L	Silo, bunker	0.86	0.09	0.73	27.47	
11	R-38	Alf Est	10/30/95	HCS-L	Silo, bunker	0.68	0.07	0.58	21.80	
11	R-5NT	Alf Est	06/05/95	HCS-L	Silo, bunker	0.21	0.02	0.18	6.65	
11	R-5NT	Alf Est	07/05/95	HCS-L	Silo, bunker	0.06	0.01	0.05	1.95	
11	R-5NT	Alf Est	08/08/95	HCS-L	Silo, bunker	0.09	0.01	0.08	2.99	
11	R-6NT	Alf Est	06/04/95	HCS-L	Silo, bunker	0.24	0.03	0.21	7.80	
11	R-6NT	Alf Est	07/05/95	HCS-L	Silo, bunker	0.07	0.01	0.06	2.34	
11	R-6NT	Alf Est	08/08/95	HCS-L	Silo, bunker	0.12	0.01	0.10	3.97	
11	R-8NT	Alf Est	06/05/95	HCS-L	Silo, bunker	0.24	0.03	0.21	7.82	
11	R-8NT	Alf Est	07/05/95	HCS-L	Silo, bunker	0.07	0.01	0.06	2.34	
11	R-8NT	Alf Est	08/08/95	HCS-L	Silo, bunker	0.15	0.02	0.13	4.89	
11	R-9	Alf Est	06/06/95	HCS-L	Silo, bunker	0.44	0.05	0.37	14.08	
11	R-9	Alf Est	07/07/95	HCS-L	Silo, bunker	0.33	0.04	0.28	10.53	
11	R-9	Alf Est	08/09/95	HCS-L	Silo, bunker	0.31	0.03	0.26	9.86	
11	RS-11S	Alf Est	06/06/95	HCS-L	Silo, bunker	0.51	0.05	0.43	16.15	

^a NIT = NITROGEN, P = PHOSPHORUS, AND K = POTASSIUM, DM = DRY MATTER.

TABLE A-12. HARVEST INFORMATION FOR THE SEVEN FARMS IN THE ON-FARM PHOSPHORUS STUDY

FARM CODE	FIELD	CROP	HARVEST DATE	HARVEST AS	STORAGE	NIT ^a	TONS / DATE		
							P	K	DM
11	RS-11S	Alf Est	07/07/95	HCS-L	Silo, bunker	0.13	0.01	0.11	4.29
11	RS-11S	Alf Est	08/09/95	HCS-L	Silo, bunker	0.40	0.04	0.34	12.73
11	RS-15-A	Alf Est	06/05/95	HCS-L	Silo, bunker	0.23	0.02	0.19	7.20
11	RS-15-A	Alf Est	07/05/95	HCS-L	Silo, bunker	0.13	0.01	0.11	4.29
11	RS-15-A	Alf Est	08/09/95	HCS-L	Silo, bunker	0.20	0.02	0.17	6.46
11	P-20	Corn	10/20/95	HMSC	High moisture	0.85	0.18	0.21	57.88
11	A-6	Rye	06/09/95	Straw	Small bale, inside	0.04	0.00	0.08	5.90
11	R-38	Rye	06/14/95	Straw	Small bale, inside	0.05	0.00	0.11	7.48
11	R-5N	Rye	06/02/95	Straw	Small bale, inside	0.06	0.00	0.14	9.86
11	R-5S	Rye	06/02/95	Straw	Small bale, inside	0.06	0.00	0.13	9.15
12	ClearPc	Corn	09/07/95	CornSilage	Silo, bunker	3.39	0.66	3.05	265.05
12	CloverPl	Corn	09/05/95	CornSilage	Silo, bunker	0.80	0.16	0.72	62.70
12	Pat's	Corn	09/05/95	CornSilage	Silo, bunker	1.82	0.36	1.64	142.50
12	SharonPl	Corn	09/05/95	CornSilage	Silo, bunker	2.37	0.46	2.13	185.25
12	SoperUp	Corn	09/05/95	CornSilage	Silo, bunker	0.95	0.19	0.85	74.10
12	Distefno	Grass Est	06/05/95	Hay-G	Small bale, inside	0.24	0.04	0.25	12.32
12	HenrichW	Grass Est	06/05/95	Hay-G	Small bale, inside	0.30	0.05	0.31	15.40
12	HenrichW	Grass Est	07/04/95	Hay-G	Small bale, inside	0.23	0.04	0.23	11.55
12	Koeners	Grass Est	06/05/95	Hay-G	Small bale, inside	0.30	0.05	0.31	15.40
12	SchweiktE	Grass Est	07/04/95	Hay-G	Small bale, inside	0.21	0.03	0.22	10.78
12	SchweiktW	Grass Est	07/04/95	Hay-G	Small bale, inside	0.12	0.02	0.12	6.16
12	SchweiktW	Grass Est	08/08/95	Hay-G	Small bale, inside	0.06	0.01	0.06	3.08
12	Tim5	Grass Est	08/08/95	Hay-G	Small bale, inside	0.09	0.01	0.09	4.62
12	Hassam	Alf Est	08/08/95	Hay-L	Small bale, inside	0.18	0.01	0.16	6.55
12	HenrichE	Alf Est	08/08/95	Hay-L	Small bale, inside	0.17	0.01	0.16	6.16
12	SchweiktE	Grass Est	06/05/95	HCS-G	Silo, bunker	0.43	0.07	0.45	19.25
12	SchweiktW	Grass Est	06/05/95	HCS-G	Silo, bunker	0.32	0.05	0.33	14.44
12	Tim5	Grass Est	06/05/95	HCS-G	Silo, bunker	0.11	0.02	0.11	4.81
12	Tim5	Grass Est	07/04/95	HCS-G	Silo, bunker	0.02	0.00	0.02	0.96
12	Drake	Alf Est	06/05/95	HCS-L	Silo, bunker	0.12	0.01	0.10	3.85
12	Drake	Alf Est	07/04/95	HCS-L	Silo, bunker	0.09	0.01	0.08	2.89
12	Drake	Alf Est	08/08/95	HCS-L	Silo, sealed	0.12	0.01	0.10	3.85
12	Drake	Alf Est	09/09/95	HCS-L	Silo, bunker	0.09	0.01	0.08	2.89

^a NIT = NITROGEN, P = PHOSPHORUS, AND K = POTASSIUM, DM = DRY MATTER.

TABLE A-12. HARVEST INFORMATION FOR THE SEVEN FARMS IN THE ON-FARM PHOSPHORUS STUDY

FARM CODE	FIELD	CROP	HARVEST DATE	HARVEST AS	STORAGE	NIT ^a	TONS / DATE			
							P	K	DM	
12	FarmRes	Alf Est	06/05/95	HCS-L	Silo, bunker	1.02	0.11	0.86	32.73	
12	FarmRes	Alf Est	07/04/95	HCS-L	Silo, bunker	0.54	0.06	0.46	17.33	
12	FarmRes	Alf Est	08/08/95	HCS-L	Silo, bunker	0.84	0.09	0.71	26.95	
12	FarmRes	Alf Est	09/09/95	HCS-L	Silo, bunker	0.48	0.05	0.41	15.40	
12	Frank'sPl	Alf Est	06/05/95	HCS-L	Silo, bunker	0.18	0.02	0.15	5.78	
12	Frank'sPl	Alf Est	07/04/95	HCS-L	Silo, bunker	0.06	0.01	0.05	1.93	
12	Frank'sPl	Alf Est	08/08/95	HCS-L	Silo, bunker	0.12	0.01	0.10	3.85	
12	Frank'sPl	Alf Est	09/09/95	HCS-L	Silo, bunker	0.12	0.01	0.10	3.85	
12	Giroux	Alf Est	06/05/95	HCS-L	Silo, bunker	0.66	0.07	0.56	21.18	
12	Giroux	Alf Est	07/04/95	HCS-L	Silo, bunker	0.24	0.03	0.20	7.70	
12	Giroux	Alf Est	08/08/95	HCS-L	Silo, bunker	0.42	0.05	0.36	13.48	
12	Giroux	Alf Est	09/09/95	HCS-L	Silo, bunker	0.30	0.03	0.25	9.63	
12	Hassam	Alf Est	06/05/95	HCS-L	Silo, bunker	0.18	0.02	0.15	5.78	
12	Hassam	Alf Est	07/04/95	HCS-L	Silo, bunker	0.12	0.01	0.10	3.85	
12	HenrichE	Alf Est	06/05/95	HCS-L	Silo, bunker	0.42	0.05	0.36	13.48	
12	HenrichE	Alf Est	07/04/95	HCS-L	Silo, bunker	0.06	0.01	0.05	1.93	
12	Kirby	Alf Est	06/05/95	HCS-L	Silo, bunker	0.36	0.04	0.30	11.55	
12	Kirby	Alf Est	07/04/95	HCS-L	Silo, bunker	0.12	0.01	0.10	3.85	
12	Kirby	Alf Est	08/08/95	HCS-L	Silo, bunker	0.30	0.03	0.25	9.63	
12	Ruben	Alf Est	06/05/95	HCS-L	Silo, bunker	0.18	0.02	0.15	5.78	
12	Ruben	Alf Est	07/04/95	HCS-L	Silo, bunker	0.09	0.01	0.08	2.89	
12	Ruben	Alf Est	08/08/95	HCS-L	Silo, bunker	0.12	0.01	0.10	3.85	
12	Ruben	Alf Est	09/09/95	HCS-L	Silo, bunker	0.09	0.01	0.08	2.89	
12	SoperLow	Alf Est	06/05/95	HCS-L	Silo, bunker	0.30	0.03	0.25	9.63	
12	SoperLow	Alf Est	07/04/95	HCS-L	Silo, bunker	0.12	0.01	0.10	3.85	
12	SoperLow	Alf Est	08/08/95	HCS-L	Silo, bunker	0.30	0.03	0.25	9.63	
12	SoperLow	Alf Est	09/09/95	HCS-L	Silo, bunker	0.12	0.01	0.10	3.85	
12	TimBorder	Alf sdg	07/04/95	HCS-L	Silo, bunker	0.06	0.01	0.05	1.93	
12	TimBorder	Alf sdg	08/08/95	HCS-L	Silo, bunker	0.30	0.03	0.25	9.63	
12	TimBorder	Alf sdg	09/09/95	HCS-L	Silo, bunker	0.15	0.02	0.13	4.81	
12	GulleyPc	Alf/Grs Es	06/05/95	HCS-M	Silo, bunker	0.31	0.04	0.29	11.55	
12	GulleyPc	Alf/Grs Es	07/04/95	HCS-M	Silo, bunker	0.16	0.02	0.14	5.78	
12	GulleyPc	Alf/Grs Es	08/08/95	HCS-M	Silo, bunker	0.26	0.03	0.24	9.63	

^a NIT = NITROGEN, P = PHOSPHORUS, AND K = POTASSIUM, DM = DRY MATTER.

TABLE A-12. HARVEST INFORMATION FOR THE SEVEN FARMS IN THE ON-FARM PHOSPHORUS STUDY

FARM CODE	FIELD	CROP	HARVEST DATE	HARVEST AS	STORAGE	NIT ^a	TONS / DATE			
							P	K	DM	-----
12	GulleyPc	Alf/Grs Es	09/09/95	HCS-M	Silo, bunker	0.18	0.02	0.17	6.74	
21	Acrs Barn	Corn	09/21/95	CornSilage	Silo, bunker	0.29	1.00	0.26	23.04	
21	Acrs Barn	Corn	09/29/95	CornSilage	Silo, bunker	1.80	0.35	1.61	140.40	
21	Horse Barn	Corn	10/08/95	CornSilage	Silo, bunker	1.29	0.25	1.16	101.09	
21	Mid West	Corn	10/08/95	CornSilage	Silo, bunker	0.96	0.19	0.86	74.88	
21	Northwest	Corn	10/06/95	CornSilage	Silo, bunker	2.03	0.40	1.82	158.40	
21	Rte117	Corn	10/17/95	CornSilage	Silo, bunker	1.77	0.35	1.59	138.24	
21	WBunker	Corn	10/01/95	CornSilage	Silo, bunker	4.31	0.84	3.88	336.96	
21	Murray	Clv/Grs Es	06/24/95	Hay-L	Small bale, inside	0.61	0.05	0.55	21.76	
21	Powerline	Clv/Grs Es	06/24/95	Hay-L	Small bale, inside	0.39	0.03	0.35	14.03	
21	ToolShed	Clv/Grs Es	06/20/95	Hay-L	Small bale, inside	0.57	0.04	0.51	20.40	
21	ToolShed	Clv/Grs Es	07/20/95	Hay-L	Small bale, inside	0.36	0.03	0.32	12.75	
21	ToolShed	Clv/Grs Es	08/30/95	Hay-L	Small bale, inside	0.21	0.02	0.19	7.65	
21	Top Hill	Alf/Grs Es	06/04/95	Hay-L	Small bale, inside	0.79	0.06	0.71	28.05	
21	Top Hill	Alf/Grs Es	07/20/95	Hay-L	Small bale, inside	0.32	0.03	0.29	11.48	
21	Underpass	Alf/Grs Es	07/12/95	Hay-L	Small bale, inside	0.26	0.02	0.24	9.35	
21	Back Laval	Alf/Grs Es	06/04/95	HCS-M	Silo, bunker	0.46	0.06	0.43	17.15	
21	Back Laval	Alf/Grs Es	07/20/95	HCS-M	Silo, bunker	0.33	0.04	0.31	12.25	
21	Back Laval	Alf/Grs Es	08/28/95	HCS-M	Silo, bunker	0.33	0.04	0.31	12.25	
21	Buses	Alf/Grs Es	06/04/95	HCS-M	Silo, bunker	0.53	0.07	0.49	19.60	
21	Buses	Alf/Grs Es	07/18/95	HCS-M	Silo, bunker	1.06	0.14	0.98	39.20	
21	Buses	Alf/Grs Es	08/30/95	HCS-M	Silo, bunker	1.12	0.15	1.04	41.65	
21	Buses	Alf/Grs Es	10/13/95	HCS-M	Silo, bunker	0.46	0.06	0.43	17.15	
21	Interstate	Alf/Grs Es	06/06/95	HCS-M	Silo, bunker	0.86	0.11	0.80	31.85	
21	Interstate	Alf/Grs Es	07/10/95	HCS-M	Silo, bunker	0.99	0.13	0.92	36.75	
21	Interstate	Alf/Grs Es	08/30/95	HCS-M	Silo, bunker	0.60	0.08	0.55	22.05	
21	River	Alf/Grs sd	07/07/95	HCS-M	Silo, bunker	2.84	0.37	2.63	105.35	
21	River	Alf/Grs sd	08/27/95	HCS-M	Silo, bunker	1.06	0.14	0.98	39.20	
21	Tin Barn	Alf/Grs Es	06/04/95	HCS-M	Silo, bunker	1.72	0.22	1.59	63.70	
21	Tin Barn	Alf/Grs Es	07/20/95	HCS-M	Silo, bunker	1.39	0.18	1.29	51.45	
21	Tin Barn	Alf/Grs Es	08/28/95	HCS-M	Silo, bunker	0.99	0.13	0.92	36.75	
21	Tin Barn	Alf/Grs Es	10/13/95	HCS-M	Silo, bunker	0.60	0.08	0.55	22.05	
21	Underpass	Alf/Grs Es	06/10/95	HCS-M	Silo, bunker	1.19	0.15	1.10	44.10	

^a NIT = NITROGEN, P = PHOSPHORUS, AND K = POTASSIUM, DM = DRY MATTER.

TABLE A-12. HARVEST INFORMATION FOR THE SEVEN FARMS IN THE ON-FARM PHOSPHORUS STUDY

FARM CODE	FIELD	CROP	HARVEST DATE	HARVEST AS	STORAGE	NIT ^a	TONS / DATE			
							P	K	DM	-----
21	Underpass	Alf/Grs Es	07/10/95	HCS-M	Silo, bunker	0.46	0.06	0.43	17.15	
21	Underpass	Alf/Grs Es	08/28/95	HCS-M	Silo, bunker	0.60	0.08	0.55	22.05	
21	Southwest	Corn	10/29/95	HMSC	High moisture	1.62	0.34	0.41	110.16	
22	01A-1B-1C	Grass Est	07/05/95	Hay-G	Silo, bunker	0.11	0.02	0.11	5.54	
22	02 rented	Grass Est	09/04/95	Hay-G	Silo, bunker	0.17	0.03	0.17	8.45	
22	03 rented	Grass Est	08/03/95	Hay-G	Small bale, inside	0.37	0.06	0.38	19.01	
22	05 front	Grass Est	08/18/95	Hay-G	Small bale, inside	0.28	0.05	0.28	14.15	
22	Bruner bck	Grass Est	08/21/95	Hay-G	Small bale, inside	0.40	0.07	0.41	20.33	
22	Bruner frt	Grass Est	08/21/95	Hay-G	Small bale, inside	0.44	0.07	0.45	22.18	
22	Eddy's	Grass Est	08/11/95	Hay-G	Small bale, inside	0.15	0.03	0.16	7.81	
22	Wool1north	Grass Est	08/02/95	Hay-G	Small bale, inside	0.12	0.02	0.13	6.34	
22	Wool2south	Grass Est	08/05/95	Hay-G	Small bale, inside	0.06	0.01	0.06	3.17	
22	01 rented	Grass Est	06/12/95	HCS-G	Silo, bunker	0.47	0.07	0.49	21.00	
22	01A-1B-1C	Grass Est	06/25/95	HCS-G	Silo, bunker	1.09	0.16	1.13	48.51	
22	01A-1B-1C	Grass Est	09/15/95	HCS-G	Silo, bunker	0.30	0.04	0.31	13.23	
22	02 rented	Grass Est	06/07/95	HCS-G	Silo, bunker	0.44	0.07	0.46	19.74	
22	03A-02lowr	Grass Est	06/15/95	HCS-G	Silo, bunker	0.44	0.07	0.45	19.57	
22	03B-D	Grass Est	06/20/95	HCS-G	Silo, bunker	0.25	0.04	0.26	11.20	
22	03B-D	Grass Est	09/05/95	HCS-G	Silo, bunker	0.26	0.04	0.27	11.48	
22	05 front	Grass Est	10/14/95	HCS-G	Silo, bunker	0.02	0.00	0.02	0.70	
22	Bruner frt	Grass Est	10/20/95	HCS-G	Silo, bunker	0.03	0.00	0.03	1.26	
22	Eddy's	Grass Est	08/12/95	HCS-G	Silo, bunker	0.17	0.03	0.18	7.77	
22	Eddy's	Grass Est	10/14/95	HCS-G	Silo, bunker	0.09	0.01	0.09	3.89	
22	Wool1north	Grass Est	10/14/95	HCS-G	Silo, bunker	0.09	0.01	0.09	3.92	
23	LH12	Corn	09/17/95	CornSilage	Silo, bunker	0.23	0.04	0.21	17.85	
23	LH2	Corn	09/15/95	CornSilage	Silo, bunker	0.24	0.05	0.22	19.13	
23	LH3	Corn	09/17/95	CornSilage	Silo, bunker	0.60	0.12	0.54	47.18	
23	LH7	Corn	09/20/95	CornSilage	Silo, bunker	1.24	0.24	1.11	96.90	
23	LH1	Grass Est	07/12/95	Hay-G	Small bale, inside	0.32	0.05	0.32	16.12	
23	LH6A	Grass Est	07/03/95	Hay-G	Small bale, inside	0.20	0.03	0.20	10.19	
23	LH6B	Grass Est	07/04/95	Hay-G	Small bale, inside	0.16	0.03	0.17	8.32	
23	LH8	Grass Est	07/15/95	Hay-G	Small bale, inside	0.38	0.06	0.39	19.21	
23	LH9	Grass Est	07/01/95	Hay-G	Small bale, inside	0.24	0.04	0.24	12.14	

^a NIT = NITROGEN, P = PHOSPHORUS, AND K = POTASSIUM, DM = DRY MATTER.

TABLE A-12. HARVEST INFORMATION FOR THE SEVEN FARMS IN THE ON-FARM PHOSPHORUS STUDY

FARM CODE	FIELD	CROP	HARVEST DATE	HARVEST AS	STORAGE	NIT ^a	TONS / DATE			
							P	K	DM	
23	LH4	Clv/Grs Es	07/10/95	Hay-L	Small bale, inside	0.23	0.02	0.21	8.32	
23	LH5	Clv/Grs sd	07/07/95	Hay-L	Small bale, inside	0.36	0.03	0.32	12.83	
23	LH1	Grass Est	06/12/95	HCS-G	Silo, bunker	0.63	0.10	0.65	28.18	
23	LH10B	Grass Est	06/17/95	HCS-G	Silo, bunker	0.96	0.15	0.99	42.88	
23	LH6A	Grass Est	06/04/95	HCS-G	Silo, bunker	0.27	0.04	0.28	12.25	
23	LH6B	Grass Est	06/07/95	HCS-G	Silo, bunker	0.36	0.05	0.37	15.93	
23	LH8	Grass Est	06/05/95	HCS-G	Silo, bunker	0.33	0.05	0.34	14.70	
23	LH8	Grass Est	06/09/95	HCS-G	Silo, bunker	0.33	0.05	0.34	14.70	
23	LH9	Grass Est	06/01/95	HCS-G	Silo, bunker	0.38	0.06	0.39	16.80	
23	LH4	Clv/Grs Es	06/11/95	HCS-M	Silo, bunker	0.75	0.10	0.69	27.72	
23	LH5	Clv/Grs sd	06/09/95	HCS-M	Silo, bunker	0.73	0.09	0.67	26.95	
23	LH12	Corn	11/04/95	HMSC	High moisture	0.60	0.13	0.15	41.15	
24	1	Corn	09/13/95	CornSilage	Silo, bunker	1.31	0.26	1.17	102.00	
24	3	Corn	09/14/95	CornSilage	Silo, bunker	0.61	0.12	0.55	48.00	
24	6	Corn	09/14/95	CornSilage	Silo, bunker	0.38	0.07	0.34	29.70	
24	8	Corn	09/13/95	CornSilage	Silo, bunker	1.03	0.20	0.93	80.52	
24	9	Corn	09/17/95	CornSilage	Silo, bunker	1.44	0.28	1.29	112.20	
24	16	Alf/Grs Es	07/15/95	Hay-L	Small bale, inside	0.95	0.07	0.85	33.79	
24	17	Alf/Grs Es	07/15/95	Hay-L	Small bale, inside	0.74	0.06	0.67	26.40	
24	18	Alf/Grs Es	07/15/95	Hay-L	Small bale, inside	0.80	0.06	0.72	28.51	
24	5	Alf/Grs Es	07/17/95	Hay-L	Small bale, inside	0.16	0.03	0.14	12.32	
24	20	Grass Est	07/03/95	HCS-G	Silo, bunker	0.02	0.00	0.02	1.75	
24	15	Alf sdg	06/10/95	HCS-L	Silo, bunker	0.14	0.02	0.12	4.46	
24	15	Alf sdg	08/02/95	HCS-L	Silo, bunker	0.14	0.02	0.12	4.46	
24	5	Alf/Grs Es	06/12/95	HCS-L	Silo, bunker	0.17	0.03	0.15	12.96	
24	5	Alf/Grs Es	08/28/95	HCS-L	Silo, bunker	0.17	0.03	0.15	12.96	
24	11	Alf/Grs Es	06/07/95	HCS-M	Silo, bunker	0.35	0.05	0.32	12.88	
24	16	Alf/Grs Es	05/15/95	HCS-M	Silo, bunker	0.36	0.05	0.34	13.44	
24	16	Alf/Grs Es	06/15/95	HCS-M	Silo, bunker	0.36	0.05	0.34	13.44	
24	16	Alf/Grs Es	08/15/95	HCS-M	Silo, bunker	0.36	0.05	0.34	13.44	
24	17	Alf/Grs Es	06/15/95	HCS-M	Silo, bunker	0.28	0.04	0.26	10.50	
24	17	Alf/Grs Es	08/15/95	HCS-M	Silo, bunker	0.28	0.04	0.26	10.50	
24	18	Alf/Grs Es	06/15/95	HCS-M	Silo, bunker	0.31	0.04	0.28	11.34	

^a NIT = NITROGEN, P = PHOSPHORUS, AND K = POTASSIUM, DM = DRY MATTER.

TABLE A-12. HARVEST INFORMATION FOR THE SEVEN FARMS IN THE ON-FARM PHOSPHORUS STUDY

FARM CODE	FIELD	CROP	HARVEST DATE	HARVEST AS	STORAGE	NIT ^a	----- TONS / DATE -----		
							P	K	DM
24	18	Alf/Gr ^s Es	08/15/95	HCS-M	Silo, bunker	0.31	0.04	0.28	11.34
24	19	Alf/Gr ^s Es	10/01/95	HCS-M	Silo, bunker	2.27	0.29	2.10	84.00
24	7	Alf/Gr ^s Es	06/01/95	HCS-M	Silo, bunker	1.56	0.20	1.45	57.96
24	6	Corn	09/15/95	HMSC	High moisture	0.73	0.15	0.18	49.88
25	03C	Oat/Barley	07/15/95	Barley	Dry grain	0.59	0.10	0.12	26.40
25	468	Oat/Barley	07/15/95	Barley	Dry grain	0.20	0.03	0.04	8.80
25	09C	Corn	09/20/95	CornSilage	Silo, bunker	0.32	0.06	0.29	25.20
25	09C	Corn	09/21/95	CornSilage	Silo, bunker	0.59	0.12	0.53	46.20
25	09C	Corn	09/22/95	CornSilage	Silo, bunker	0.30	0.06	0.27	23.10
25	05C	Grass Est	06/18/95	Hay-G	Small bale, inside	0.20	0.03	0.20	9.90
25	07	Alf/Gr ^s Es	06/10/95	Hay-G	Small bale, inside	0.43	0.07	0.44	21.78
25	07	Alf/Gr ^s Es	08/15/95	Hay-G	Small bale, inside	0.23	0.04	0.24	11.88
25	7A	Grass Est	06/10/95	Hay-G	Small bale, inside	0.35	0.06	0.36	17.82
25	7A	Grass Est	08/15/95	Hay-G	Small bale, inside	0.20	0.03	0.20	9.90
25	04	Grass Est	06/08/95	HCS-G	Silo, bunker	0.57	0.09	0.59	25.58
25	04	Grass Est	07/21/95	HCS-G	Silo, bunker	0.28	0.04	0.29	12.67
25	04	Grass Est	09/02/95	HCS-G	Silo, bunker	0.41	0.06	0.42	18.10
25	01J	Alf/Gr ^s Es	06/08/95	HCS-M	Silo, bunker	0.31	0.04	0.28	11.32
25	01J	Alf/Gr ^s Es	07/21/95	HCS-M	Silo, bunker	0.21	0.03	0.19	7.77
25	01J	Alf/Gr ^s Es	09/02/95	HCS-M	Silo, bunker	0.16	0.02	0.15	5.91
25	03C	Oat/Barley	08/15/95	HCS-M	Silo, bunker	0.28	0.04	0.26	10.50
25	06C	Clv/Gr ^s Es	06/02/95	HCS-M	Silo, bunker	0.36	0.05	0.34	13.44
25	06C	Clv/Gr ^s Es	07/15/95	HCS-M	Silo, bunker	0.15	0.02	0.14	5.70
25	06C	Clv/Gr ^s Es	08/27/95	HCS-M	Silo, bunker	0.26	0.03	0.24	9.50
25	06HM	Alf/Gr ^s Es	06/08/95	HCS-M	Silo, bunker	0.41	0.05	0.38	15.10
25	06HM	Alf/Gr ^s Es	07/21/95	HCS-M	Silo, bunker	0.28	0.04	0.26	10.36
25	06HM	Alf/Gr ^s Es	09/02/95	HCS-M	Silo, bunker	0.22	0.03	0.21	8.33
25	02C	Corn	10/12/95	HMSC	High moisture	0.50	0.10	0.12	33.75
25	02C	Corn	10/30/95	HMSC	High moisture	0.14	0.03	0.04	9.72
25	02HM	Corn	10/27/95	HMSC	High moisture	0.18	0.04	0.04	12.15
25	05HM	Corn	10/10/95	HMSC	High moisture	0.21	0.04	0.05	14.18
25	07C	Corn	10/12/95	HMSC	High moisture	0.18	0.04	0.04	11.97
25	07HM	Corn	10/11/95	HMSC	High moisture	0.18	0.04	0.04	11.97

^a NIT = NITROGEN, P = PHOSPHORUS, AND K = POTASSIUM, DM = DRY MATTER.

TABLE A-12. HARVEST INFORMATION FOR THE SEVEN FARMS IN THE ON-FARM PHOSPHORUS STUDY

FARM CODE	FIELD	CROP	HARVEST DATE	HARVEST AS	STORAGE	NIT ^a	TONS / DATE			
							P	K	DM	
25	08C	Corn	10/10/95	HMSC	High moisture	0.12	0.03	0.03	8.10	
25	08C	Corn	10/28/95	HMSC	High moisture	0.18	0.04	0.04	12.15	
25	09C	Corn	10/28/95	HMSC	High moisture	0.30	0.06	0.07	20.25	
25	02J	Soybeans	09/25/95	Soybeans	Dry grain	1.83	0.17	0.49	26.67	
25	03AC	Soybeans	09/25/95	Soybeans	Dry grain	1.25	0.12	0.33	18.30	
25	04AHM	Soybeans	09/29/95	Soybeans	Dry grain	1.34	0.13	0.36	19.58	
25	03C	Oat/Barley	07/16/95	Straw	Small bale, inside	0.23	0.02	0.50	35.20	
25	03HM	Oat/Barley	08/10/95	Straw	Small bale, inside	0.03	0.00	0.06	3.96	
25	468	Oat/Barley	07/20/95	Straw	Small bale, inside	0.06	0.00	0.12	8.80	

^a NIT = NITROGEN, P = PHOSPHORUS, AND K = POTASSIUM, DM = DRY MATTER.