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## MAC: Manure Application Calculator Computer Software



OREGON STATE UNIVERSITY EXTENSION SERVICE

## **MAC: MANURE APPLICATION CALCULATOR (PILOT)**

**APPLICATION OF ANIMAL MANURE AND OTHER  
WASTE MATERIALS TO CROPLAND IN ORDER TO OBTAIN  
MAXIMUM ECONOMIC BENEFIT WHILE PROTECTING THE  
SURFACE AND GROUNDWATER QUALITY**

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J. Ronald Miner, Roger A. Nordstedt and  
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ABSTRACT

This document helps determine the best way to apply livestock or poultry manure to cropland to obtain the maximum economic benefit while protecting the surface and groundwater quality of the area. This program helps organize the information needed to make this decision and performs the necessary calculations. It remembers the intermediate values so the calculation can be completed without unusual pain or suffering.

The program is for a livestock or poultry producer in Florida or someone advising a producer. The program was kept as general as possible so the user can enter specific information and receive recommendations unique to a specific enterprise.

This program is based on the INTeractive PROgram development system (INTPRO) distributed by the University of Florida. This system was selected to make the information highly accessible to either an experienced or novice computer user. The program and all of the software needed to run it are on the disk provided with this user's guide. You as user can view the use of this software as you would a visit to an expert, being paid to provide professional advice. The expert listens carefully as you answer then gives you his most considered judgement. You are also free to ask him or her to consider another situation.

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## **INTRODUCTION**

The application of manure to cropland is both an economic and environmentally significant decision. Properly managed and applied to cropland, manure is a valuable resource that can replace chemical fertilizer that would otherwise need to be purchased to obtain appropriate yields for an economically viable enterprise. Under many situations, research data indicate animal manures to have properties that provide benefits not available from chemical fertilizers. Alternately, irresponsibly managed or applied in amounts that exceed the capability of the land to utilize the nutrients, manure application can contribute to surface water pollution and to groundwater contamination. Low application of manure results in less than optimal crop yields.

Determining the correct manure application rates can be a relatively complex set of calculations that should be based on the nutrient content of the manure as applied, the nutrient status of the soil, the projected nutrient utilization of the crop, and any nutrient losses anticipated in the system. This program facilitates that set of calculations and provides the farmer/livestock producer with a convenient way to plan manure disposal. Provisions are also included to incorporate any regulatory limitations into the application calculations.

### **Intended Users**

This program serves the needs of livestock and poultry producers under two specific situations. First as a planning aid; as plans are being made to establish or expand an enterprise, the program helps estimate the land area needed for manure disposal based on the animal numbers, manure management scheme, anticipated crops, and regulatory constraints. Second, the program accepts results of manure analyses to calculate a specific application rate and a land area to which the manure can be applied.

The program assumes no particular computer skills on the part of the operator. The program starts when you type a single command. Thereafter, user instructions appear on the screen. In addition, you have the option of moving backwards in the program if you need to change an answer or to see what would happen if an alternate answer is given

### **What to Expect**

Regard this program as an expert engaged to advise you on manure application rates. It gives you the choice of using any analytical data you may have available or it enables you to enter information about the species of animals you raise in confinement, the number of animals, their average weight and certain features of the manure management system. At several

points, it asks you to indicate nutrient losses in certain operations. Each time information of this type is requested, Help Screens are provided to let you know the typical range of values for various systems. You will have the opportunity to select the description most like yours and then to pick the value which you think best describes your particular system.

Toward the end of the program, you will indicate the nitrogen and/or phosphorus application rate you want used as a basis for land application. That rate can be based on a soil analysis and the recommendation of your agronomist or it can be based on standard agronomic recommendations for your area. It can also be based on application constraints set by your local or regional pollution control authorities. The better that value, the more reliable are the recommendations from the program. Remember that the output from a program of this type is no better than the input you provide.

#### Hardware Requirements

This program was designed for use on 100% IBM PC compatible microcomputers with the following:

IBM or Microsoft DOS(disk operating system) version 3.0 or higher.

512 kilobytes of random access memory (RAM).

A computer with a CGA, VGA or EGA graphics system preferred to use the full color capabilities of the program.

#### Conventions

This document contains step-by-step instructions. At times, you will to enter commands. When asked to enter a command, an instruction similar to the following will appear.

Type **dir a:** <Enter>

When the word "Type" appears, press the keys corresponding to the boldface characters that follow. Once all characters have been typed, press the 'Enter' key. Pressing the "Enter" key tells the computer to carry out or "execute" the instruction you just typed. Some keyboards use the word, "Return" for "Enter". If yours is one of these, proceed to press "return" whenever the "Enter" command appears.

## **GETTING STARTED**

### **Installation and Operation**

No installation is required to run this program on an IBM compatible microcomputer with the necessary adapter cards and video display monitor described in 'Hardware requirements'.

### **Starting the Program**

To start the program, insert the Floppy disk provided, label side up, in drive A or B of your computer and make that drive the current drive, by typing a command similar to the following. If you placed the provided disk in drive A,

Type **A:** <Enter>

Then:

Type **INTPRO MANURE** <Enter>

After a slight delay to load the software, the program will start. The INTPRO banner screen appears as shown in Fig. 1. The INTPRO banner screen disappears within three seconds and the actual program begins. The program can also be run from a hard disk by first copying the disk distributed with this manual onto the hard disk.

Fig. 1. Banner Screen of INTPRO

## Stopping the Program

There are three ways to stop the program.

1. Run the program to its conclusion, at which time it will stop execution and return to DOS.
2. Stop the program at any time by using the following key command:

Press **<ALT>-<F10>**

3. Alternatively,

Press **<Esc> (escape)**

Either the Alt-F10 keystroke combination or Escape enables a user to exit the program from any screen.

## Return to the Beginning

You can also return to the beginning of the program at any time by pressing F9.

Press **<F9>**

## **INTRODUCTION TO THE SCREENS YOU WILL SEE**

### **Screen Layout**

There are three basic types of screens. Each of these screen types has certain characteristics with which you will become familiar as you use the program. Each has three similar segments which you will come to recognize.

#### **Title window**

The upper three lines of your screen display a title as black text on a white background. This title assists you in reacting to the screen, but no further response is required.

#### **Interaction window**

Immediately below the title is the interaction window which contains the main business of the screen. Information may be presented, a choice between options requested, or you may be asked to provide specific input such as the number of animals in your system or the nitrogen application rate suggested by your most recent soil analysis. This window appears as white text on a blue background with a color monitor.

#### **Help window**

The help window is found in the lower left corner of the screen. The window contains two lines that remind you of available help. Press the F1 key to call help specific to the screen display. The F2 key calls a screen listing how the special keys are used in the program. You can press these keys at any time for help.

Help screens are not available for all screens. Help screens are included when the developer thought they would be needed.

### **Key Commands**

Certain keys are used by INTPRO and this application program for specific purposes as listed in Table 1. When you press one of these keys, the program responds as indicated.

**Table 1. List of special keys and program responses**

Key	Program response
F1	Helpful information for the current screen
F2	Information on the use of the special keys
F9	Restart the program from the beginning
Alt-F10	Exit the program, return to DOS
PgUp	Go back to the previous screen
PgDn	Go to the next screen
Enter	Signals the end of a numeric entry or indicates your choice from a series of options
Backspace	Moves the cursor one character to the left and erases the character in that space

### Information Screens

Information screens provide information to the user. This can be general background or the results of calculations based on data you have provided. No response is required except to move to the next screen by pressing any key. Many people prefer to press the space bar to move on.

### Choice Screens

Choice screens are used when you must provide information. Choice screens generally contain a question in the upper part of the interaction window and two or more choices immediately below. One of the choices will be highlighted. Move the highlight to your choice by pressing the cursor up key (often represented by an up arrow) or the cursor down key (down arrow). When you highlight your choice, press the Enter or Return key to record your response.

Pressing the Enter key also signals the program that you are ready for it to proceed.

Many of the choice screens are critical to your getting the information you need. Should you be uncertain which choice matches your interest, Press F1 to check if additional information is available that can help you.

Note: Frequently your indicating a choice activates a calculation routine within the program that will require a few seconds to complete. During that time, the screen may grow dark. Do not despair. As soon as the calculation is complete, the next screen will appear.

### Numeric Screens

At several points in the program you will be requested to enter numbers in response to questions. These questions will be presented in Numeric screens. Immediately below the title block you will find a question or instructions and below that, one or more prompts. Each prompt will be followed by a space for your answer. The cursor will highlight one of the answer spaces. You should enter your answer in the highlighted field. Immediately to the left of the highlight, enclosed in square brackets, will be a default value. If you agree with the value in the highlighted area, Press Enter and the cursor will move to the next blank. If not, type your value then Press Enter. Remember you can erase numbers using the Backspace key. When you Press Enter after the final number has been entered, the program will move forward.

As you will discover, many of the numeric questions have been provided a range of acceptable values. If you enter a number outside this range, you will see the message, "Your response of \_\_\_\_\_ is not within the acceptable range of \_\_\_\_\_ to \_\_\_\_\_. At this point, reconsider your answer and enter a new response within the acceptable range.

Note: Frequently your entering a numeric response activates a calculation routine within the program that will require a few seconds to complete. During that time, the screen may grow dark. Do not despair. As soon as the calculation is complete, the next screen will appear.

## SAMPLE RUN

As an example of how the program operates, let us assume that you the operator of a dairy, 600 head, have a lagoon and that you have had a sample of that lagoon water analysed. The analyses has been returned to you and you want to apply the liquid from the lagoon to a Bahiagrass field. You have estimated that you have 2.4 million gallons of the material available for application during the coming season.

Analysis of lagoon sample	
Total solids	760 mg/l
Total nitrogen	360 mg/l
Phosphorus as P	68 mg/l
Potassium as K	47 mg/l
pH	7.4

You want to know how much you should apply per acre and how many acres you will need to spread it over. You have had a soil analysis conducted and it was recommended that you apply 400 pounds of N per year, 100 pounds after each cutting, that you apply 60 pounds per year of phosphorus as P<sub>2</sub>O<sub>5</sub> and no potassium.

1. Initiate the program by inserting the disk in Drive A of your IBM compatible microcomputer and establish Drive A as the operating drive by typing **A:** and pressing the <Enter> key.
2. Type **INTPRO MANURE <Enter>**
3. The INTPRO banner should appear for a few seconds followed by the first information screen which explains the purpose of this program.
4. Press F1 if you want to know additional information about the program or its developers, otherwise, press the space bar.
5. Proceeding in this manner, you will view two more information screens and then will be presented a Choice Screen that asks if you have data available. Three options are given:

Data available; N, P and K concentrations and quantities.  
Data available; N, P and K concentrations but no quantities.  
No data available regarding concentrations or quantities.

Using the cursor control keys, move the highlight to the first option, if it is not already there, and press <Enter>.

6. Another choice screen appears asking, in what units your analyses are available.

mg/l or parts per million  
pounds per acre foot  
pounds per thousand gallons  
pounds per ton

Using the cursor control keys, move the highlight to the first option, mg/l, if it is not already there, and press <Enter>.

7. The next screen will ask you to enter your analyses in "mg/l or parts per million since that is the set of units you selected. Alternatively, another set of units would have been requested if that is what you selected.

Nitrogen incl. ammonia [0] \_\_\_\_  
Phosphorus as P [0] \_\_\_\_  
or Phosphorus as P2O5 [0] \_\_\_\_  
Potassium as K [0] \_\_\_\_  
or Potassium as K2O [0] \_\_\_\_

With the cursor highlighting the space for a nitrogen concentration, enter your value (360). Press <Enter> to move the cursor to the next data entry point, enter the P concentration (68), press <Enter> twice to move the highlight to the potassium as K line and type 47 <Enter>.

Had your values for phosphorous been given as P2O5. You would have moved the cursor to the "as P2O5" line and entered the value. Similarly, with the potassium concentration. Review your entries and use the cursor control keys to position the cursor so you can correct any errors. Press <Enter> to move on to the next screen.

8. The next screen will ask you to select how you want to input your quantity data. Select from among the options. (Millions of gallons per year) Move the highlight to this line and press <Enter>.
9. The next screen will ask you to enter the quantity of material you have available in the units you selected, millions of gallons per day. Type 2.4 <Enter>, review your entry, and if everything is correct, press Enter.
10. After a brief period of a blank screen, the next screen will summarize the input you have provided (Fig. 2). After you assure yourself it is accurate, press <Enter> and you will see a screen that presents the total quantity of N, P, and K available to you (Fig. 3).

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**Manure nutrients available**

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You indicated you had manure or other waste materials available as follows:

Quantity: 2.4 million gallons per year  
Nitrogen: 360 mg/l or parts per million  
Phosphorus as P: 68 mg/l or parts per million  
Phosphorus as P2O5: 0 mg/l or parts per million  
Potassium as K: 47 mg/l or parts per million  
Potassium as K2O: 0 mg/l or parts per million

---

Press any key to continue

---

**Figure 2. Screen indicating input data**

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**Nutrients available for land application**

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Based on this information, you can base your land application on the following:

Nutrient	Available daily	Available yearly
Nitrogen, pounds	20	7206
Phosphorus as P2O5, pounds	8	3093
Potassium as K2O, pounds	3	1133

---

Press any key to continue

---

**Figure 3. Screen indicating quantities of nutrients available based on the input data.**

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11. At this point, you are entering the land application segment of the program. Two information screens are available to help you decide whether you want to have the program base its calculations on nitrogen or phosphorus or on a complete nutrient recommendation. The next screen will let you choose between those three. Since you have a complete recommendation, select, "Complete Nutrient Recommendation". There are "Help screens" along the way you can reach by pressing F1.
12. You will be asked to estimate how much nitrogen will be lost due to ammonia volatilization during the application process. A "Help Screen" is available. A value of 25% is typical for lagoon water applied using sprinkler irrigation

equipment. Enter the value of 25 in the highlighted area then press Enter.

13. The next screen will respond to your input by summarizing how much nitrogen was lost due to volatilization and how much is left for crop use (Fig. 4)

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Nitrogen available for crop production

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Based on this information, you have provided to me:

Nitrogen available in manure: 7206 lb./year

Estimated nitrogen loss during application: 25 percent

Nitrogen left for crop production: 5404 lb./year

Nitrogen loss due to volatilization: 1802 lb./year

---

Press any key to continue

---

Figure 4. Screen indicating quantity of nitrogen available after an allowance is made for volatilization during land application.

14. Since you indicated you had a complete fertilization recommendation, you will be asked to enter that information in the next screen. Please enter this information for N, P, and K as the individual nutrients are highlighted. In this example, you will enter 400 for Nitrogen, 60 for P as P<sub>2</sub>O<sub>5</sub>, and 0 for potassium.

15. The next two screens (Figures 5 and 6) will provide you recommendations based on the nitrogen and phosphorus application rates you selected. You will see how many acres can be fertilized using either as the basis and in each case know the resulting application rate of the other two nutrients.

Land area based on a complete fertilizer recommendation

---

You indicated a fertilizer recommendation as follows:

Nitrogen: 400 Lb./ Acre  
Phosphorus: 60 Lb./ Acre expressed as P2O5  
Potassium: 0 Lb./ Acre expressed as K2O

By using the nitrogen application rate,

Land used for manure application: 13 Acres  
Nitrogen application rate: 400 Lb./ Acre  
Phosphorus application rate: 238 Lb./ Acre  
expressed as the oxide, P2O5  
Potassium application rate: 87 Lb./ Acre  
expressed as the oxide, K2O

---

Press any key to continue

---

Figure 5. Screen indicating land required for disposal of the lagooned material based on the indicated nitrogen application rate

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Land area required for manure application based on a complete fertilizer recommendation.

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By using the phosphorus application rate,

Land used for manure application: 52 Acres  
Nitrogen application rate: 105 Lb./ Acre  
Phosphorus application rate: 60 Lb./ Acre  
expressed as the oxide, P2O5  
Potassium application rate: 22 Lb./ Acre  
expressed as the oxide, K2O

Note! Although this strategy makes the maximum use of the available phosphorus, it may require that supplemental nitrogen be added.

---

Press any key to continue

---

Figure 6. Screen indicating land required for disposal of the lagooned material based on the indicated phosphorus application rate

16. If you press the space bar at this point, you will return to the disk operating system.

Note: If you press <F9> and repeat the process but select the option based on concentration data only being available, input only the quality data, the program will calculate how much of the lagoon water you should apply to the fields to achieve the desired nutrient application rates. You will find that you will need to apply a total of 6 inches over the year.

## ERROR MESSAGES AND SOLUTIONS

This program using INTPRO has several built-in error messages. The messages are divided into three categories: user interface error messages, input error messages, and developer error messages. The messages are arranged alphabetically within each category. In each category, each error message is displayed in a gray box followed by a solution.

### User Interface Error Messages

### User Interface Messages

User interface error messages indicate that a key has been pressed in an attempt to perform an operation which cannot be performed from the presently displayed screen.

#### Message

```
Sorry, no further help available for  
key commands.
```

#### Solution

The F2 key was pressed for help with key commands, then the F1 or F2 key was pressed. Since the program has no more to say on that subject, this message appears. To exit the screen, press the space bar.

#### Message

```
Sorry, no help is available for  
this screen.
```

#### Solution

The F1 was pressed for help information, but no help is available for this screen. The question or information presented should be self-explanatory or discussed in the documentation.

#### Message

```
Sorry, no screen to back up to.
```

---

### Solution

The PgUp key was pressed from the first screen of the program or the program does not remember the previous screen. The program only remembers the 40 to 50 most recent screens for backing up.

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### Input Error Messages

### Input Error Messages

Input error messages indicate a problem in the responses a user has entered. The sample application performs a range check and a consistency check. Range checks are performed on numeric inputs to verify that they are within reasonable limits. A consistency check is used to verify that data items entered by a user are consistent with previously entered data items. Following are the input error messages.

#### Message

```
.....  
Your response of xx is not within  
the acceptable range of x to xx.  
.....
```

#### Solution

The value entered in response to the numeric prompt was not within the limits set by the developer. The limits are displayed in the text of the message. The value must be reentered.

#### Message

```
.....  
You are not allowed to enter a width  
that is greater than the length.  
Press a key to continue.  
.....
```

#### Solution

This message will appear on the 'Home size' screen if the width is greater than the length. The sample application requires that the width be less than the length. If this message occurs, check the values that have been entered and if necessary, switch the width and length values.

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### Developer Error Messages

### Developer Messages

There are several error messages which could occur if one of the program files becomes corrupted. These error messages are used by application developers to identify errors in the logic of the program. Should an error message be displayed, which is not listed previously, call the IFAS Software Support office at (904) 392-7353. Please be prepared to provide the text of the message.

## **BACKGROUND**

This program represents the accumulated experience of several livestock waste management specialists and the research results of numerous long term efforts. Those researchers and extension specialists having a direct involvement in the development of this particular format for the information are listed in the Acknowledgement section. In addition, however, the accumulated wisdom and insights of the entire livestock waste community of experts was utilized as a resource.

### **Specific References:**

**ASAE Data: ASAE D384 Manure Production and Characteristics. p385,  
ASAE Standards, 1985.**

**Florida Cooperative Extension Service, March 1990. Soil and Water  
Testing, CES Circular 817.**

**Soil Facts, Poultry Manure as a Fertilizer Source. The North  
Carolina Agricultural Extension Service, AG-439-5, 7-90, 8pp.**

**Moore, J. A. and M. J. Gamroth. 1989. Calculating the fertilizer  
value of manure from livestock operations. Oregon State  
University Extension Service, EC1094, 8pp.**

#### **WHERE TO GET FURTHER HELP**

Livestock and poultry waste management remains a significant problem for many producers and as environmental regulations become increasingly demanding, the constraints on manure disposal will become increasingly difficult. Although intended to be helpful, this computer software program will not completely resolve the issue. Livestock and poultry producers are encouraged to contact their local extension office for any information they have available. For more specific help, you are encouraged to contact the following:

**Dr. J. Ronald Miner  
Extension Water Quality Specialist  
Department of Bioresources Engineering  
Oregon State University  
Corvallis, OR 97331-3906  
Phone: 503-737-6295**

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