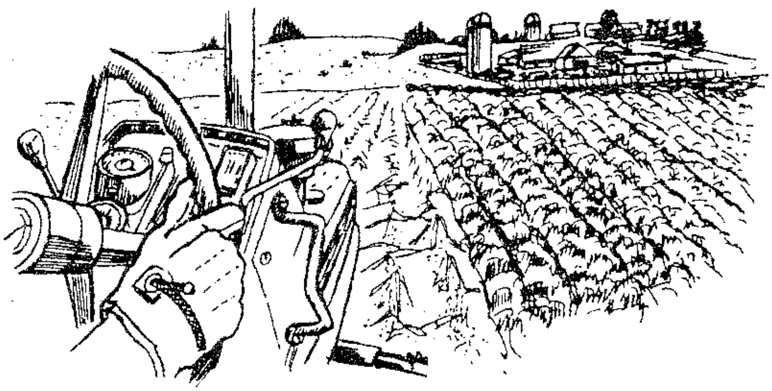
FORAGE PRODUCTION:

A PRO-DAIRY Management Focus Workshop
For Farm Managers

PARTICIPANTS' MANUAL
Revised October, 1991



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Cornell Cooperative Extension

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Forage Production

PRO-DAIRY

NEW YORK DAIRY FARM PROFITABILITY AND PRODUCTIVITY PROJECT

Special thanks to the following contributors to this publication: William J. Cox, Robert F. Lucey, Robert R. Seaney, Elson J. Shields, Larry E. Chase, Renee M. Marcellus, Timothy W. Smithling, The Soil Conservation Service, Cornell Cooperative Extension agents, faculty, and staff, and the PRO-DAIRY staff.

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References

- Approximate Dry Matter Capacity of Silos
- Estimating Yields
- Relative Corn and Hay Yield Estimates for Agricultural Soils Within Each County of New York
- Integrated Pest Management
- Scouting Calendars
  - Alfalfa IPM Scouting Calendar
  - Corn IPM Scouting Calendar
  - Winter Wheat IPM Scouting Calendar
  - Livestock IPM Scouting Calendar
- Helpful Materials for Practicing IPM
- Cornell Recommends for Field Crops
- Cornell Field Crops and Soils Handbook

Forage Production Feedback Sheets

Date ______________________________

County ______________________________

Workshop Site ______________________________

Section 1. Please rate each part of the course on a scale of 1 (low value) to 5 (high value) according to its contribution to your goals regarding this workshop. Circle one number for each area.

1. Welcome at door and completion of registration forms
(Low Value) 1 2 3 4 5 (High Value)

Comments: ______________________________

2. Teaching team introduction, warm-up and agenda sharing
(Low Value) 1 2 3 4 5 (High Value)

Comments: ______________________________

3. Quality Forage
(Low Value) 1 2 3 4 5 (High Value)

Comments: ______________________________

4. Dairy Herd Requirements for Quantity of Forage
(Low Value) 1 2 3 4 5 (High Value)

Comments: ______________________________

5. Managing Forage Production by Crop Rotation
(Low Value) 1 2 3 4 5 (High Value)

Comments: ______________________________

6. The Farm's Forage Supplying Power
(Low Value) 1 2 3 4 5 (High Value)

Comments: ______________________________

7. Homework Assignment
(Low Value) 1 2 3 4 5 (High Value)

Comments: ______________________________

END OF SESSION I

8. Class II Agenda
(Low Value) 1 2 3 4 5 (High Value)

Comments: ______________________________

9. Managing the Soil Resource for Forage Production
(Low Value) 1 2 3 4 5 (High Value)

Comments: ______________________________

10. Input Management
(Low Value) 1 2 3 4 5 (High Value)

Comments: ______________________________

11. Putting Manure in its Place
(Low Value) 1 2 3 4 5 (High Value)

Comments: ______________________________

12. Completion Windows for Spring Field Operations
(Low Value) 1 2 3 4 5 (High Value)

Comments: ______________________________

13. Homework
(Low Value) 1 2 3 4 5 (High Value)

Comments: ______________________________

END OF SESSION II

14. Class III Agenda
(Low Value) 1 2 3 4 5 (High Value)

Comments:____

15. Completion Windows for First Cutting
(Low Value) 1 2 3 4 5 (High Value)

Comments:____

16. Harvest and Storage Management
(Low Value) 1 2 3 4 5 (High Value)

Comments:____

17. Is There Gold in Those Pastures
(Low Value) 1 2 3 4 5 (High Value)

Comments:____

18. Protecting the Forage Crop Investment in the Field
(Low Value) 1 2 3 4 5 (High Value)

Comments:____

19. Putting the Forage Production Plan Together
(Low Value) 1 2 3 4 5 (High Value)

Comments:____

20. Feedback
(Low Value) 1 2 3 4 5 (High Value)

Comments:____

21. Resource Material
(Low Value) 1 2 3 4 5 (High Value)

Comments:____

Section 2. At the conclusion of the Forage Production course, please help us to improve the course by answering the following questions.

2a. What did you like best about the course?

2b. What did you like the least about the course?

2c. If you had to change one thing about the course, what would you change?

2d. Please rate the content of the workshop by circling one number in each category.

Useless	1	2	3	4	5	Useful
Impractical	1	2	3	4	5	Practical

2e. Please rate the discussion leaders for the workshop by circling one number in each category.

Amateur	1	2	3	4	5	Professional
Disorganized	1	2	3	4	5	Well prepared
Uniformed	1	2	3	4	5	Knowledgeable

2f. Please give your comments about the following resource materials you received during the course.

Forage Production Course Book: ____________________

Field Crop Record Sheets: ____________________

Crop Record Diary: ____________________

2g. We welcome any additional comments or suggestions on the workshop or the PRO-DAIRY program.

3. Your Name: (Optional) ____________________

ACTIVITY 1

Quality Forage

I. Learning Goals of this Activity

1. To reaffirm the value of quality forage on the dairy farm.

2. To analyze your own farm situation regarding quality forages.

II. Key Points

1. Recognize that quality forage is a primary contributor to the productivity and profitability of the dairy farm.

2. Reconsider and possibly update your objectives and goals regarding quality forage.

3. The general relationship between quality and quantity of forage will be discussed with the intention of instilling the concept that high quality forage can be grown on most soil resources but yield potential is driven more by soil capability.

4. The value of quality forage needs to be recognized.

Quality Forages

R. Clinton Young
Extension Specialist

One of the primary resources of virtually any well managed, profitable dairy farm is high quality forages. While it is certainly possible to feed and supplement less than high quality forages for milk production, it will likely be done at a penalty in the form of increased out-of-pocket expenditures, less than optimum milk production, poorer herd health and other negative production parameters. It is obvious that one of the goals to increased profitability should be the raising, harvesting, storing and, then, proper utilization of high quality forages.

While profitable forage management is an opportunity area in itself, the end product, the forage, is an indispensable item within the well conceived feeding program. Because the two topics (Feeding and Forage Management) are so basically intertwined, considerations in long term plans need to be made addressing this joint issue to maximize the productivity and profitability of both enterprises.

In considering goals for quality forage, it should be recognized that there may be differences in those goals depending on the end use of the forage. While goals such as optimum harvest date and proper harvest and storage techniques are something everyone should work towards, the type of forage also needs to be recognized. Milkers in early lactation and young calves may best utilize high quality alfalfa, dry cows would be better off with a relatively low quality mixed grass. Heifers, depending on their age, could be fed varying qualities of hay crop depending on the total makeup of their ration. Goals need to be thought of in terms of what the final objective may be.

Another point that needs to be emphasized is that protein content is not the sole criteria for determining forage quality. A good illustration is quality grass forage or corn silage and their importance, if not absolute need, in a well balanced feeding program for certain groups within the milking herd. The rather widespread misconception that the only high quality hay crop forage is clear seeded alfalfa, needs to be put into proper perspective. In talking about forage, the word quality (as a goal) has little to do with the species involved. Consideration of fiber values (both ADF and NDF) to measure feeding value are as, if not more, important than looking at protein as the sole means of judging quality.

High quality forage can be raised on virtually any tillable land resource. Dairy farm managers with less than optimum soil types may feel that they are at a disadvantage in raising quality forage when their basic disadvantage is actually only in yield potential. The maximum utilization of the available land resources should be the prime consideration in planning an effective program for the production of quality forages. It is worth noting that quality forages can be grown on virtually any farm but, neither harvested nor fed as such due to incomplete plans for harvesting and storage.

Under the above reasoning then, quality forage might be defined as: The field crops that can potentially be used to optimize the productivity and profitability of all herd groups on the dairy farm.

Exactly how much quality forage might be worth depends on how it is utilized on your farm. In terms of general benefits, it can yield higher milk production, less out-of-pocket costs for supplemental feed, better herd health, higher dry matter intakes and higher profits if sold. Exact dollar value can be closely determined by comparing supplemental costs in a feeding program with forages of varying quality. The value, if sold as a cash crop, is readily apparent based on market value.

If optimum profitability and productivity are to be objectives of the dairy farm, one of the critical keys to reaching them needs to be goals with well developed tactical plans for the production and feeding of high quality forages.

Quality Forage Defined

Roughage that has high potential to optimize the productivity and the profitability of individual or groups of animals.

Forage Production Idea Sheet
Forage Quality

Ideas I like in this section	What I will do to follow up	Other information I need to follow up

ACTIVITY 2

Dairy Herd Requirements for Quantity of Forage

I. Learning Goals of This Activity

1. Estimate how much feed your dairy herds need.
2. Compare your feed needs with what is actually produced to gain a better understanding of your current situation.
3. To plan a balance between forage produced and the forage fed by using an appropriate ration and crop rotation.

II. Key Points

1. To maximize the production of a dairy herd it is necessary to have enough feed, either produced or purchased, to meet the needs of both the milking animals and heifers which are the future production.
2. Producing the correct type of feeds in the correct quantities is a difficult task with many reasons why the wrong amounts are produced.
3. Farms may produce the total tons of dry matter needed to feed all the animals, but if the types of feeds being fed do not match what the crop rotation is producing, the farm will run out of one feed and then another.

Estimated Yearly Feed Needs vs. Feed Produced.

YEARLY FEED NEEDS (Dry Matter)

(_______# cows) x (6.5 tons D.M./cow°) = _________ Tons D.M. for cows

(_______# heifers) x (2.75 tons D.M./heifer°°) = + _________ Tons D.M. for heifers

_________ Total tons needed

YEARLY FEED PRODUCED (Dry Matter)

(_______ acres corn silage) x (________ tons/acre) x (.35) = _________ Total tons D.M. corn silage

(_______ acres hay crop) x (_______ tons/acre) x (.90) = + _________ Total tons D.M. hay

_________ Total tons supply

Do total tons needed = total tons supplied?

° = 6.5 tons of Dry Matter/year is based on a 5.5 tons consumption plus 18% loss from fermentation and harvesting losses.

°° = 2.75 tons of Dry Matter/year is based on a 2.25 tons consumption plus 22% loss from harvesting and fermentaion. This is a higher loss than for the cows to reflect the higher % hay often fed.

This is based on average quality feed, remember as quality increases, dry matter intake increases, which increases the amount of feed needed.

Forage Production Idea Sheet
Dairy Herd Requirements for Quantity of Forage

Ideas I like in this section	What I will do to follow up	Other information I need to follow up

ACTIVITY 3

Managing Forage Production by Crop Rotation

I. Learning Goals of this Activity

1. Understand that the crop rotation is the framework that the forage production plan is built on.

2. Gain a better understanding of the impact of crop rotation on the quantity and quality of feed produced as well as the cost of producing that feed.

II. Key Points

1. After the desired crop system suitable to the soil resource has been chosen, the crop rotation is the overall plan which dairy farmers in New York should use to build their other crop plans or their soil resources. Thus all crop plans being developed need to be compatible with the objectives of the crop rotation. The rotation is often not chosen by objectives but by default because of decisions in tactical planning (i.e. 2 lbs. of atrazine when the field should be seeded next year).

2. Crop rotation planning is the forgotten management tool for meeting yield, quality, and cost of production objectives, goals and, therefore, the mission of the dairy farm manager. It has a tremendous impact on the profitability of the farm. It underlies the entire crop program which is the basis of your cost of feed, which is part of the cost of producing milk, and regulates a great deal of profit potential. Crop costs have been identified by the major lending agencies as, "<u>the biggest hidden profit and loss on the farm today</u>".

3. Crop rotation can be used to adjust the ratio of corn silage to hay crop that is fed.

Soils Should Drive the Rotation Which Drives What the Cows Are Fed. If You Feed Differently, Purchase the Difference From Off the Farm.

Corn : Hay Crop Dry Matter Ratios Produced With Various Crop Rotations

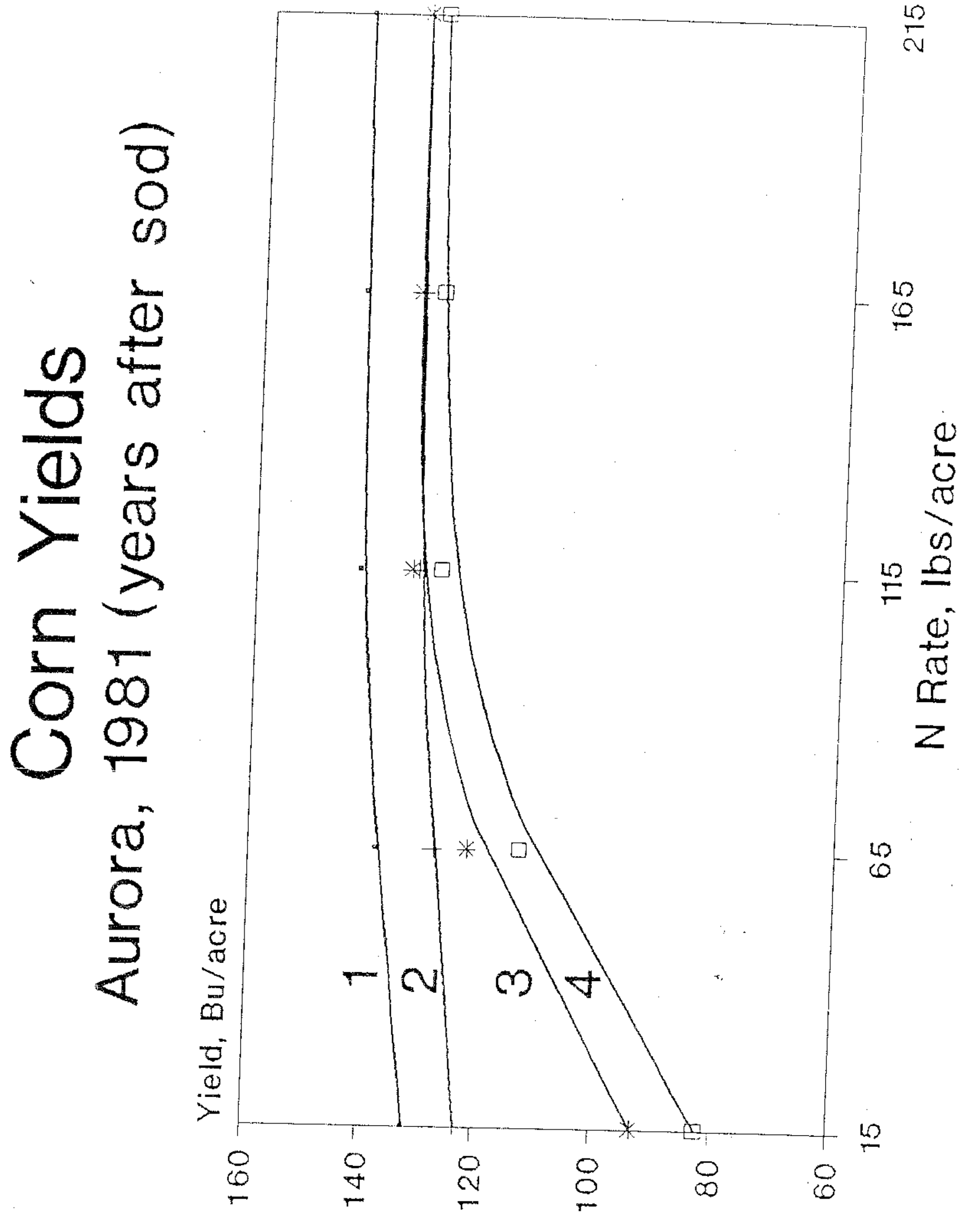
YEARS Corn Silage : Hay Crop				DRY MATTER Corn Silage : Hay Crop			AVERAGE YEARLY Tons/Acre/Year
5 CS	:	6 HC	=	58% CS	:	42% HC	3.76 T/A
5 CS	:	5 HC	=	61% CS	:	39% HC	3.93 T/A
4 CS	:	5 HC	=	56% CS	:	44% HC	3.94 T/A
3 CS	:	5 HC	=	50% CS	:	50% HC	3.90 T/A
2 CS	:	5 HC	=	41% CS	:	59% HC	3.76 T/A
1 CS	:	5 HC	=	27% CS	:	73% HC	3.57 T/A
1 CS	:	4 HC	=	31% CS	:	69% HC	3.83 T/A
2 CS	:	4 HC	=	45% CS	:	55% HC	4.00 T/A
3 CS	:	4 HC	=	54% CS	:	46% HC	4.13 T/A
2 CS	:	3 HC	=	52% CS	:	47% HC	4.09 T/A*

* Poorly drained soil

Crop Rotation

The implementation of a management plan to grow a sequence of crops in an attempt to optimize crop quality, yield, and cost of production.

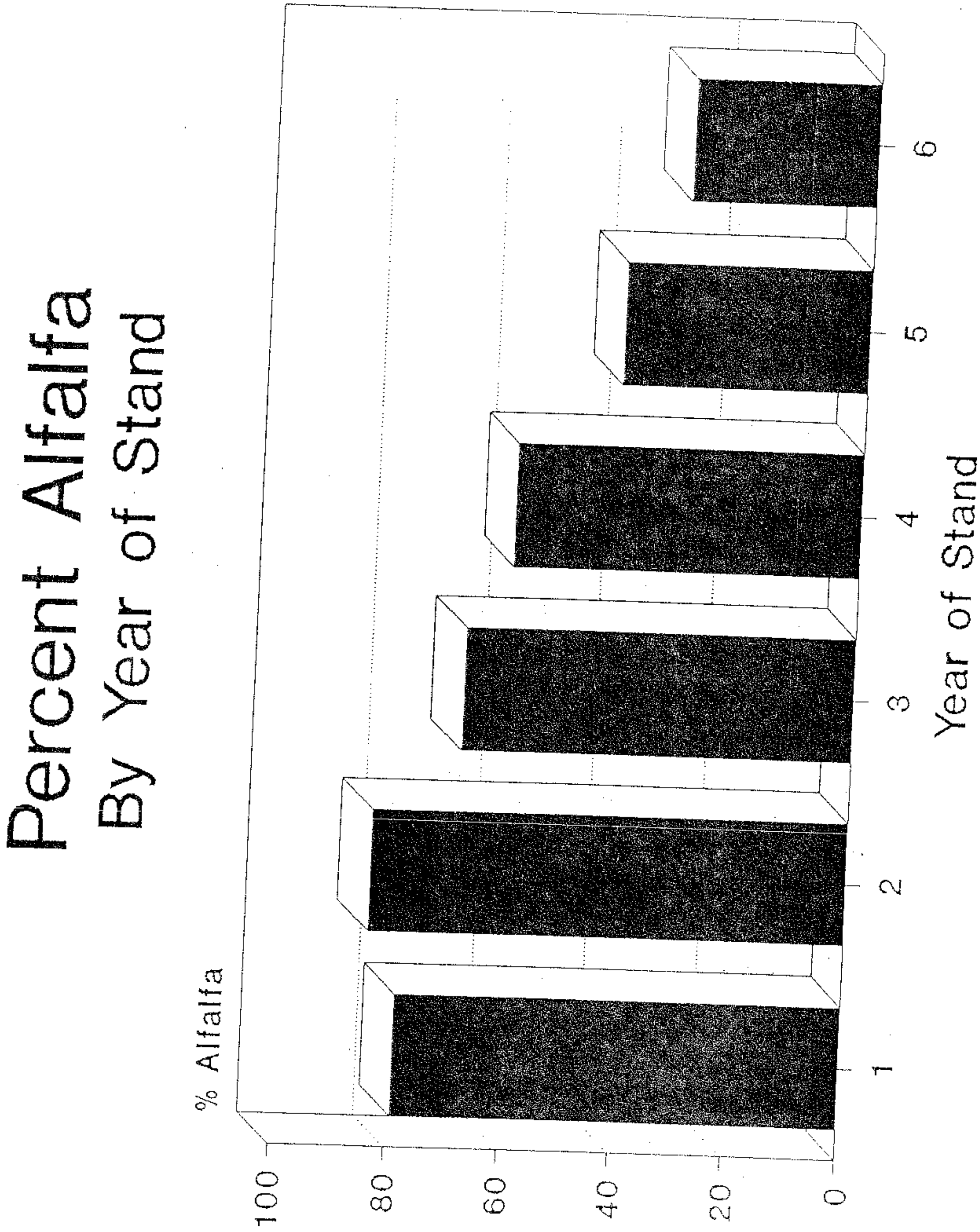
Optimal crop rotations minimize problems with weeds, diseases, insects, and deteriorating soil conditions.

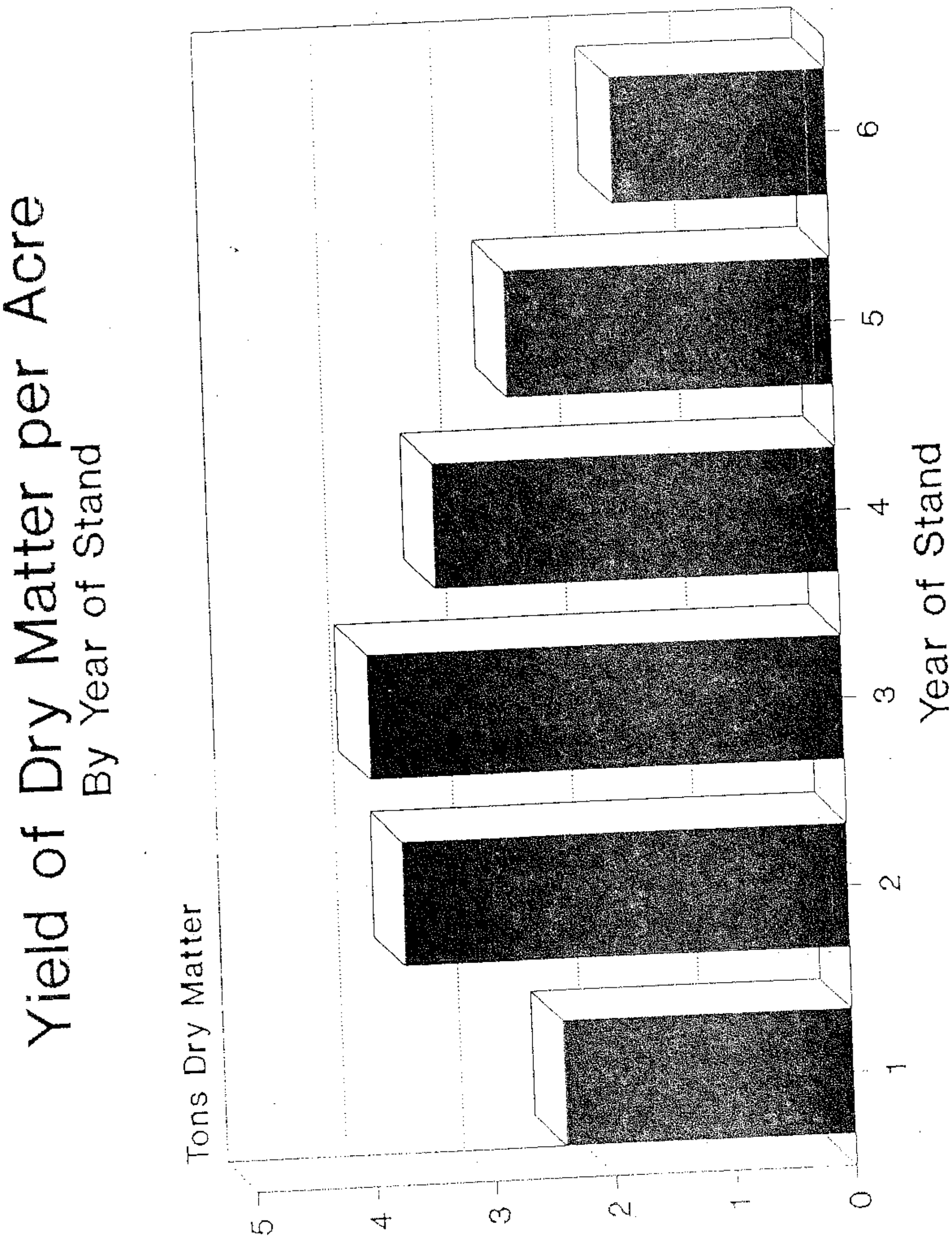

Corn Yields
Aurora, 1981 (years after sod)
Yield, Bu/acre
160
140
120
100
80
60
1
2
3
4
15
65
115
165
215
N Rate, lbs/acre

Rotation Impacts on Yield and Cost of Fertilizer N in Corn

Year of Corn	N Cost	Yield
1	$ 8.00	129
2	17.25	117
3	33.25	108
Continuous	28.75*	102

*less yield so less N needed (Wisconsin data)


Percent Alfalfa
By Year of Stand
% Alfalfa
100
80
60
40
20
0
1
2
3
4
5
6
Year of Stand


Yield of Dry Matter per Acre
By Year of Stand
Tons Dry Matter
0
1
2
3
4
5
1
2
3
4
5
6
Year of Stand

Crop Rotation Record

Year __ Year __ Year __ Year __ Year __

Field Name	Acres	Yrs. in Crop	Yrs. in Crop	Yrs. in Crop	Yrs. in Crop	Yrs. in Crop

Forage Production Idea Sheet
Crop Rotation

Ideas I like in this section	What I will do to follow up	Other information I need to follow up

ACTIVITY 4

The Farm's Forage Supplying Power

I. Learning Goals of this Activity

1. Calculate, as best you can, your own farm yields.
2. Compare your actual yields with potential yields based on soil types. This will help you recognize opportunity areas in crop production and management.

II. Key Points

1. Yields that are much below potential indicate opportunities in both the management and crop production practices on the farm.
2. To identify problems and opportunities, crop production records are essential.
3. Perennial problem fields that produce low yields and low quality should be closely evaluated and possibly abandoned much as cattle are culled.

Silo

Draw a map of the different forages in the silo at the end of the crop season

Diameter ___________

Product	Settled depth* in silo at filling	DM%

* Total depth of all silage at the end of filling with that product.

Approximate Dry Matter Capacity of Silos*

Depth of Settled Silage (feet)	Inside Diameter of Silo 10	12	14	16	18	20	22	24	26	28	30
2	0	1	1	1	2	2	2	2	3	3	4
4	1	2	2	3	4	5	5	6	8	9	10
6	2	2	3	4	5	7	8	10	11	13	15
8	3	4	5	7	9	11	13	16	18	21	24
10	4	5	7	9	11	14	17	20	24	28	32
12	5	7	9	11	14	18	22	26	30	35	40
14	5	8	11	14	17	22	26	31	36	42	48
16	6	9	12	17	21	26	32	37	44	51	58
18	7	11	14	19	24	29	35	42	49	57	65
20	8	12	16	21	27	33	40	47	56	65	74
22	9	14	19	24	30	38	48	54	64	74	85
24	11	15	21	27	34	43	52	61	72	83	96
26	12	17	23	30	38	48	58	68	81	94	107
28	13	19	26	35	44	53	64	76	90	104	119
30	15	21	29	38	47	59	71	84	99	115	132
32	16	23	32	41	52	65	78	93	109	127	145
34	18	25	34	45	57	70	85	101	119	137	158
36	19	28	37	48	62	76	92	109	129	150	172
38	21	30	41	53	67	82	100	118	139	161	185
40	22	32	44	57	72	89	107	127	150	173	199
42	24	34	47	61	77	95	115	137	161	186	214
44	26	37	50	65	82	102	123	146	172	200	229
46	27	39	53	69	88	108	131	155	183	212	244
48	29	42	56	74	93	115	140	166	195	226	260
50	31	44	60	78	99	122	148	175	206	239	274
52	32	47	64	83	105	129	157	186	219	254	291
54	34	49	67	88	111	137	165	197	231	267	306
56	36	51	71	93	117	144	174	207	243	282	324
58	38	54	74	98	123	151	183	218	261	297	339
60	40	56	78	102	129	159	192	228	273	309	357
62					135	167	201	239	287	324	374
64					142	174	210	250	301	339	391
66					149	182	219	260	314	354	407
68					155	190	228	271	328	369	424
70					162	198	237	282	342	384	441
72								293	356	400	458
74								305	371	415	476
76								316	385	431	493
78								328	400	446	511
80								339	415	462	528

To find the tons remaining in a silo after part of the silage is removed: (1) find the tons of silage when the silo was filled, (2) find the tons in a silo filled to the height equal to the depth of silage removed, (3) subtract the number of tons in Step (2) from the number of tons in Step (1). Example: A 20 foot silo filled to a settled depth of 60 feet and 22 feet were fed off. (1) 20 x 60 equals 159 tons (2) 20 x 22 equals 38 tons (3) 159 minus 38 equals 121 tons remaining.

* This table was adapted from a silo capacity table developed by the National Silo Association, 1201 Waukegan Road, Glenview, Illinois and added to by the Department of Agricultural Engineering and Agricultural Economics, the University of Wisconsin.

Yield Per Acre Work Sheet

Hay

	Tons DM		Tons H.E.
Haycrop Silage	_____	÷ 0.90 =	_____
Dry Hay		+	_____

Total H.E. = _____ ÷ _____ Acres = _____ Tons H.E./Acre

Corn Silage

Tons DM Tons 30% DM

_____ ÷ 0.3 = _____ ÷ _____ Acres = _____ Tons Corn Silage/Acre

High Moisture or Dry Corn

Total Dry Shell Corn Equivalent

_____ Bu. ÷ _____ Acres = _____ Bu. Corn/Acre

Field Crop Work Sheet – Field Information

Farm Name ________ Date ______

Field # or Name	Acres	Soil Name	Slope	Most Recent Soil Test Values					Yield Potential (T/A)		
				Year	pH	Ec/A	P2O5	K2O	Years	Corn	Hay

Teaching Example - Forage Crops

Agricultural Soils - Corn and Hay Yield Ratings - Cortland County

Map Symbl	Soil Name	Slope Texture	Drainage	Soil Modifier	pH	Yrs	Corn Yield	Index	Hay Yield	Index	TDN Yield	Index	F	C	Cap	G
BaB	Bath	03-08 CN SIL	W		LO	5	21	80	5.0	83	3.35	73.8		P	2E	3
BaC	Bath	08-15 CN SIL	W		LO	3	18	69	4.0	66	2.48	54.6		I	3E	5
BaD	Bath	15-25 CN SIL	W		LO	1	14	53	3.5	58	1.86	41.0			4E	6
HdA	Howard	00-03 GR L	W to EXC		LO	7	23	88	5.5	91	4.04	89.0		P	2S	2
HdB	Howard	03-08 GR L	W to EXC		LO	6	22	84	5.5	91	3.74	82.4		P	2S	2
HdC	Howard	08-15 GR L	W to EXC		LO	3	18	69	4.5	75	2.65	58.4		I	3E	5
HdD	Howard	15-25 GR L	W to EXC		LO	1	16	61	4.0	66	2.12	46.7			4E	6
LaB	Langford	03-08 CN SIL	W to MW		LO	6	20	76	4.5	75	3.30	72.7		I	2W	3
LaC	Langford	08-15 CN SIL	W to MW		LO	3	17	65	3.5	58	2.24	49.3		I	3E	6
LaD	Langford	15-25 CN SIL	W to MW		LO	1	15	57	3.0	50	1.65	36.3			4E	7
VbB	Volusia	02-08 CN SIL	SMP		LO	3	16	61	3.0	50	2.01	44.3		I	3W	6
VbB3	Volusia	02-08 CN SIL	SMP		LO	3	14	53	2.5	41	1.71	37.7		I	3E	7
VbC	Volusia	08-15 CN SIL	SMP		LO	2	14	53	2.5	41	1.56	34.4			3E	7
VbD	Volusia	15-25 CN SIL	SMP		LO	0	0	0	2.0	33	1.00	22.0			4E	8

Forage Production Idea Sheet
The Farm's Forage Supplying Power

Ideas I like in this section	What I will do to follow up	Other information I need to follow up

Homework

I. Instructions

1. Crop History
   - Please complete the Field Crop Work Sheet, "Crop History" for as many fields as you can.
   - If you don't have time to collect information on all of your fields, choose representative fields for corn, hay crop, different soil types, different drainage groups and differing yield potentials.
   - Gather as much information as you have or take a best guess.

2. Managing Animal Manure
   - Please calculate the approximate capacity of your manure spreader using Work sheet 4, Table 1 of the Managing Animal Manure work sheet series.
   - It is important to actually calculate the capacity for box spreaders as manufacturers may calculate capacity differently.

Field Crop Work Sheet – Crop History

Farm Name ____________ Year ________

Field # or Name	Crop/Yr.	(Yields) –(T/A)– Potential	Manure Applied #/A	Fertilizer Applied #/A Lime	N	P2O5	K2O	Comments: Weeds, Pests, Problem Areas

Field Crop Work Sheet – Crop History

Farm Name ______________ Year __________

Field # or Name	Crop/Yr.	(Yields) –(T/A)– Potential	Manure Applied #/A	Fertilizer Applied #/A Lime	N	P2O5	K2O	Comments: Weeds, Pests, Problem Areas

Managing Animal Manure

Work Sheet No. 4. Determine the number of manure spreader loads required to apply the application rate in C.2, Work Sheet 3.

Example: Continued from Work Sheet 3.

Calculations	*Example*	*Field #*	*Field #*	*Field #*	*Field #*	*Field #*
1. Spreader Capacity (use equations from Table 1)						
a. Liquid System (Express in units of 1000s of gal per load)						
b. Nonliquid system; cut off spreader =	16.9' x 6.3' x 3.2' = *340 ft3*					
tons per load =	340 ft3 x 62 lb/ft ÷ 2000 = *10.5 tons.load*					
2. Numbers of loads needed						
a. Loads per acre = manure rate in C.2 ÷ spreader capacity from Table 1.	*30/10.5 = 2.9 loads/A*					
b. Loads per field = loads per acre x acres	*2.9 x 15 = 44 loads*					

Table 1. Approximate manure spreader capacities

Nonliquid System

Spreader Volume (Measure all dimensions in feet and tenths of feet.)

- Box spreader: cubic feet = length x width x average depth.
- Barrel spreader: cubic feet = 0.303 x d2 (diameter squared) x length.
- Irregular shapes: Use manufacturer's rated capacity. Estimate the percentage of a full load.

Spreader capacity

Tons per load = $\frac{\text{cubic feet x 62 lb cubic feet}}{\text{2000 lb per}}$ (Use 55 lb per cubic feet) for extremely dry manure

Liquid system

Tank spreader: Use manufacturer's data to determine gallon capacity. Estimate the percentages of a full load. There are approximately 8300 lb in 1000 gal.

ACTIVITY 5

Managing the Soil Resource for Forage Production

I. Learning Goals of this Activity

1. To learn to use crop records for crop production planning.

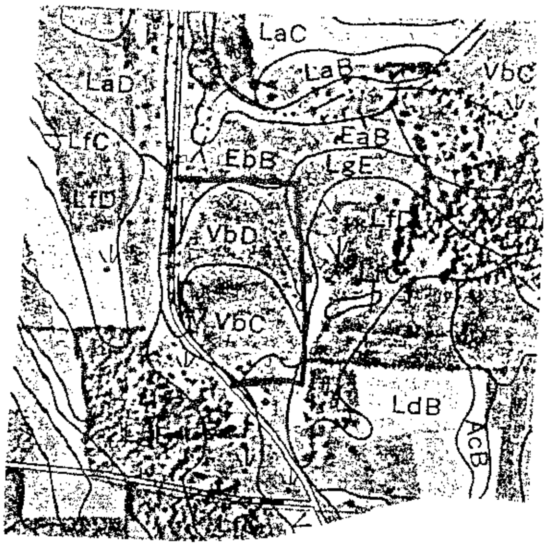
2. To have an opportunity to evaluate a few of your fields needing specific attention.

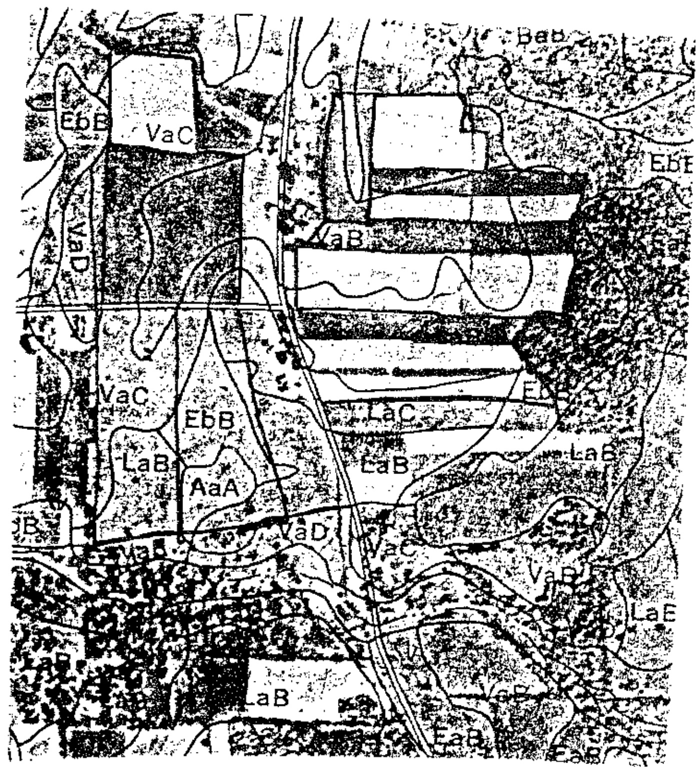
II. Key Points

1. The decisions of when to rotate and what type of seeding mixtures to use are important in the wise management of the soil resource on the farm. Good rotation practices reduce erosion, contribute to good soil structure, limit insect and disease buildup, reduce cost, and increase yields.

2. Choosing suitable hay mixtures can increase yields and produce different types of forage for the different quality needs of the farm. Good decision making and planning in this area can maintain optimum production.

3. This exercise uses a case farm example. The farm is set up to be somewhat typical of a 70 cow dairy farm. There are a range of soil types that can be used as examples that most resemble your farm.


LaC
LaB
VbC
LaD
LfC
EaB
EbB
LgE
LfD
VbD
VbC
LdB
AcB


EbB
VaC
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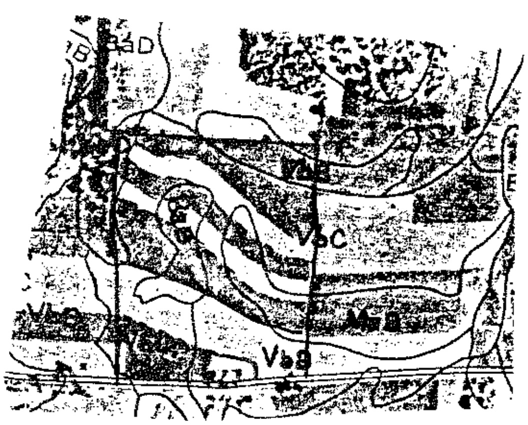
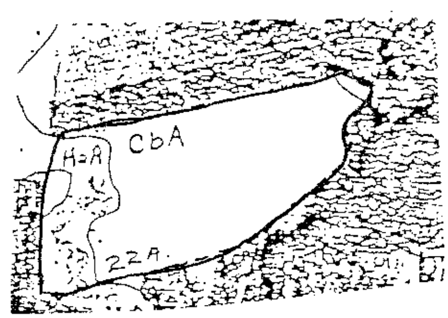
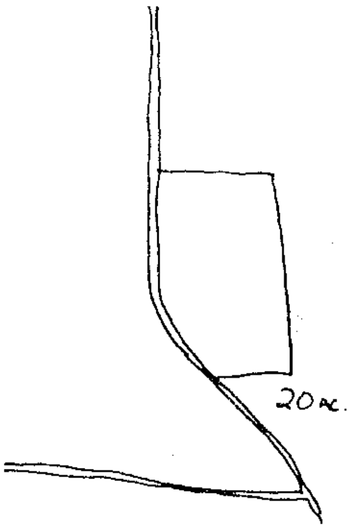
LaC
LaB
AaA
VaD
LaB
LaB


VbC
VbB

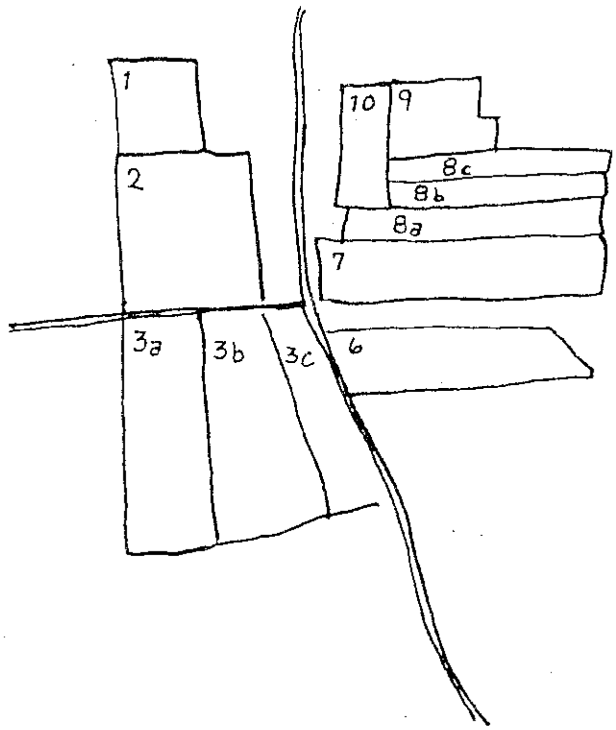

CbA

Field Map

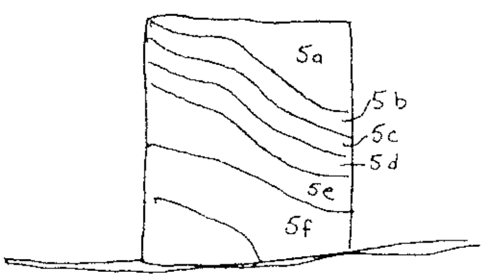
J. and J. Doe Farm



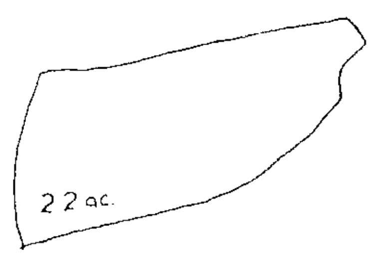
Uncle Bob's



Home Farm



Field #5 (2 miles from barn)



Field #4 (4 miles)

Field Crop Work Sheet – Field Information

Farm Name J & J Doe   Date ______

Field # or Name	Acres	Soil Name	Slope	Most Recent Soil Test Values: Year	pH	Ec/A	P2O5	K2O	Yield Potential (T/A): Years	Corn	Hay
1	7.2	Volois–Howard	8–15		5.8	14	7(M)	95(M)	3	19	4.5
2	17	Volois–Howard	3–8/8–15		6.1	10	8(M)	100(M)	3/6	19/22	4.5/5.5
3a	15	Volois–Howard	3–8/8–15		5.9	13	6(M)	110(M)	3/6	19/22	4.5/5.5
3b	12	Erie/Volois–Howard	3–8		5.6	16	2(L)	120(M)	3/6	19/22	3.0/5.5
3c	11	Langford	3–8						6	20	4.5
5a	7.5	Volusia	8–15						2	14	2.5
5b	4.0	Volusia	8–15						2	14	2.5
5c	4.0	Volusia	8–15						2	14	2.5
5d	4.0	Volusia	8–15						2	14	2.5
5e	7.0	Volusia	8–15						2	14	2.5
5f	9.5	Volusia	8–15						2	14	2.5
4	22	Chagrin	0–2		6.0	8	4(M)	105(H)	7	24	5.5
6	13	Langford	3–8/8–15		6.3		4(M)	210(VH)	6/3	20/17	4.5/3.5
7	16	Langford/Volois–Howard	3–8		5.9	13	5(M)	230(VH)	6	22/20	5.5/4.5
8a	6	Volois–Howard	3–8		5.8	13	4(M)	110(M)	6	22	5.5
8b	6	Volois–Howard	3–8		5.9	12	4(M)	160(M)	6	22	5.5
8c	7.5	Volois–Howard	3–8		6.1		3(L)	150(M)	6	22	5.5
9	6	Bath	3–8		6.0	18	2(L)	180(M)	5	21	5.0
10	3.5	Bath/Langford/ Volois–Howard	3–8/8–15		6.1		3(L)	150(M)	3/6	17/27	3.5/5.5
Uncle Bob's	20	Volusia	2–8/8–15		5.6	19	1(L)	100(M)	3/2	16/14	3.0/2.5

Field Crop Work Sheet – Crop History

Farm Name J & J Doe Year ______

Field # or Name	Crop/Yr.	(Yields) –(T/A)– Potential	Manure Applied #/A	Fertilizer Applied #/A Lime	N	P2O5	K2O	Comments: Weeds, Pests, Problem Areas
1	4th Corn	19 (16)	20		40	40	40	
2	4th Alfalfa	4.5/5.5 (4.0)	20		40	80	80	Quackgrass 50% Alfalfa 25%
3a	2nd Alfalfa	4.5/5.5 (4.0)	20		0	60	90	Excellant
3b	1st Alfalfa	4.5/5.5 (1.5)	–	2.0	20	80	80	No Legume – Good grass stand
3c	2nd Corn	20 (15)	20		100	80	80	Some quackgrass lots foxtail
4	Cont. Corn	24 (18)	–		100	80	80	Some goosenecking Rootworm Nutsedge
5a	4th Corn	14 (10)	10		120	60	60	
5b								
6	2nd Alfalfa	4.5/3.5 (3.0)	20		0	20	20	Alfalfa gone in Low spots – dandelions
7	1st Corn	20/17 (18)	20		40	40	40	Good yield Some quack
8a	3rd Corn	22 (16)	20		40	40	40	some velvetleaf
8b	4th Alfalfa	5.5 (2.75)	–		0	60	90	Alfalfa 2 plants/ft2 Vert. wilt, quack, dandelion
8c	1st Alfalfa	5.5 (2.25)	–	2.0	20	80	80	Alfalfa/grass Looks good
9	4th Corn	21 (15)	20		40	40	40	Many rootworm adults, some Quackgrass, velvetleaf
10	3rd Hay	3.5/5.5 (3.5)	10		0	40	40	Birdsfoot/grass O.K.
Uncle Bob's	10th Hay	(1.25)	–					Mostly grass Weeds

Field Crop Work Sheet – Crop Planning

Farm Name ____________ Year ________

Field # or Name	Past Crops°	Planned 19___ Crops	Yields: Potential T/A	Yields: Goal T/A	Manure for 19___ T/A	Planned 19___ Fertilizer Applied #/A: Lime	N	P_2O_5	K_2O	Zn	Pesticides Planned for 19___

°List crop history for last five years. For example: Hay in 1984, Corn in 1985–86, Hay in 1987–88, would be HCCHH.

Forage Production Idea Sheet
Managing Soil Resources for Forage Production

Ideas I like in this section	What I will do to follow up	Other information I need to follow up

ACTIVITY 6

Input Management

I. Learning Goals of this Activity

1. To learn what the necessary tools are to plan crop inputs.

2. To learn what information is available for crop input planning and learn how to use the Cornell Recommends for Field Crops.

3. To learn the importance of accurately taking a soil test and filling out the soil test information form.

4. By practicing crop input planning, you will learn how to put together your own plan.

II. Key Points

1. To complete this exercise it is important that all homework has been completed. The crop record exercise should be completed prior to this class and a list of what crops are going to be grown on which fields next year is needed.

2. Input management is one of the key areas in forage management planning where crop yield and quality is lost and/or profitability is reduced because crop inputs are applied in excess of what is necessary for getting maximum economic returns. A relatively small amount of time invested in planning can result in high returns.

3. The Cornell Recommends for Field Crops will, for New York, be the best resource (next to their crop records) to help farm managers plan what inputs their crops need. The recommendations are based on years of scientific research and unbiased professional judgement of an experienced and well trained faculty.

Information Sheet for Agronomic, Commercial Fruit, and Commercial Vegetable Crops

Cornell Nutrient Analysis Laboratories
New York State College of Agriculture and Life Sciences • A Statutory College of the State University
804 Bradfield Hall, Cornell University, Ithaca, NY 14853 • 607/255-4540

CLIENT

NAME

STREET

CITY STATE ZIP

TELEPHONE

NAME

ORGANIZATION

STREET

CITY STATE ZIP

COUNTY

TOWNSHIP

COUNTY TO RECEIVE RESULTS IF DIFFERENT FROM ABOVE

ID

SAMPLE BAG NUMBER (COPY FROM BAG)

(NO MORE THAN 10 CHARACTERS)

[ ] YES
[ ] NO

MONTH DAY YEAR

Soil

For recommendations, provide the soil name. The soil properties influence yield and crop fertilizer needs.

SOIL NAME (e.g. Mardin) .AND. MAP SYMBOL (e.g. MaB)

Obtain name of soil occupying the largest area of the field from a soil survey, conservation plan, or from the Cooperative Extension Association.

[ ] NO-TILL
[ ] 1-7 INCHES
[ ] 7-9 INCHES
[ ] 9+ INCHES

[ ] NONE
[ ] INADEQUATE
[ ] ADEQUATE
[ ] EXCELLENT

Soil Estimation

Complete only if the soil name was not provided above. If the soil name is unknown, completing this section will allow us to "estimate" the soil type and make recommendations.

SYMBOL (e.g. E4-2)

Obtain from soil association map. Obtain map from county extension office.

[ ] EXCELLENT
[ ] GOOD
[ ] FAIR
[ ] POOR

[ ] SANDY
[ ] LOAMY
[ ] SILTY
[ ] CLAYEY

[ ] HILLTOP
[ ] HILLSIDE
[ ] VALLEY FLOOR
[ ] PLAIN

Crops

Indicate the crops grown. The fertilizer recommendations are based on crops in the rotation for the next three years. Past crop history is also important.

PLACE CROP CODES FROM BACK OF SHEET BELOW

PAST CROPS	FUTURE CROPS
LAST YEAR	THIS CROP
2 YEARS AGO	2ND YR CROP
3 YEARS AGO	3RD YR CROP

THIS CROP

CROP NAME OR VARIETY

Indicate crop if not on the code list.

19 ______ Establishment Year

When will a cover crop be planted?

[ ] BEFORE NEXT CROP
[ ] BEFORE 2ND YEAR'S CROP
[ ] BEFORE 3RD YEAR'S CROP

Special Crops

Recommend for
[ ] PRE-PLANT PREPARATION
[ ] ESTABLISHED CROP

Ground cover
[ ] GRASS
[ ] HERBICIDE STRIP
[ ] MULCH
[ ] CULTIVATED

If surface and subsurface soil samples were taken, please indicate **BOTH** sample bag numbers below:

SURFACE SOIL

SUBSURFACE SOIL

TISSUE SAMPLE ID #

How severe is scab?
[ ] NONE
[ ] MINOR
[ ] MODERATE
[ ] SEVERE

Will the variety grown be scab resistant?
[ ] YES
[ ] NO

Manure

Proper management of nutrients in animal or green manures can reduce the need for fertilizer. Complete the following if a recent sod crop was grown, if manure was applied last year, or will be applied in the next three years.

MANURE FROM
[ ] CATTLE
[ ] POULTRY
[ ] SWINE
[ ] OTHER

MANAGEMENT
[ ] DAILY SPREAD
[ ] STORAGE

RATE OF MANURE APPLICATION

Solid (T/A)	-OR-	Liquid (GAL/A)
	LAST YR	
	THIS YR	
	2ND YR	
	3RD YR	

Estimate % legume in current or recent hay or pasture sod.

[ ] 0 (100% grass)
[ ] 1-25%
[ ] 25-50%
[ ] 50-100%

19____
Year sod was plowed or killed.

(Continued on reverse side.)

SOIL TESTS

Tests

Standard tests and lime requirement are determined on all samples and are included with purchase of soil bag.
Standard tests include:
phosphorus, potassium, calcium, magnesium, aluminum, iron, manganese, zinc, nitrate, pH, lime requirement, no-till pH and organic matter.

[ ] Substitute pH in CaCl2 for pH in water.
[ ] No-till 0-1 inch sample enclosed.

Additional Tests

EXTRA TESTS may be requested at the fee indicated below:

[ ] Boron . . . . $ 5.00

[ ] Soluble Salts 2.00

Please indicate method of payment for EXTRA TESTS:

[ ] Check enclosed (made payable to Cornell Univ.)
[ ] Paid Cooperative Extension*
[ ] Bill Industry Representative

***AUTHORIZED SIGNATURE REQUIRED** ____________

PERENNIAL

CODE INITIAL ESTABLISHMENT:
ALE Alfalfa
AGE Alfalfa-grass
ABE Alfalfa-trefoil-grass
BTE Birdsfoot trefoil
BGE Birdsfoot trefoil-grass
BCE Birdsfoot trefoil-clover
BSE Birdsfoot trefoil-seed
CLE Clover
CGE Clover-grass
CSE Clover-seed production
CVE Crownvetch
GRE Grasses(brome,timothy,etc)
PGE Pasture w/improved grasses
PLE Pasture with legumes
WPE Waterways, pond dikes,etc.

CODE TOPDRESSING ESTABLISHED STANDS:
ALT Alfalfa
AGT Alfalfa-grass
ABT Alfalfa-trefoil-grass
BTT Birdsfoot trefoil
BGT Birdsfoot trefoil-grass
BCT Birdsfoot trefoil-clover-grass
BST Birdsfoot trefoil-seed-production
CLT Clover
CGT Clover-grass
CST Clover-seed production
CVT Crownvetch
GRT Grasses(brome, timothy, etc)
PNT Pasture with native grasses
PGT Pasture with improved grasses
PLT Pasture with legumes
WPT Waterways, pond dikes, etc.

ANNUAL

CODE
BSP Barley-spring
BSS Barley-spring with legume
BWI Barley-winter
BWS Barley-winter with legume
BDR Beans-dry
BUK Buckwheat
COG Corn-grain
COS Corn-silage
MIL Millet
OAT Oats
OAS Oats-seeded with legume

CODE
RYC Rye-cover crop
RYS Rye-seed production
SOG Sorghum-grain
SOF Sorghum-forage
SSH Sorghum-sudan hybrid
SUD Sundangrass
SOY Soybeans
SUN Sunflower
WHT Wheat
WHS Wheat with Legume

CODE
ASP Asparagus
BND Beans-dry
BNL Beans-Lima
BNS Beans-Snap
BET Beets
BRP Broccoli-Transplanted
BRS Broccoli-Seeded
BUS Brussels Sprouts
CBF Cabbage-Transplanted
CBS Cabbage-Seeded
CAR Carrots

CODE
CFP Cauliflower-Transplanted
CFS Cauliflower-Seeded
CEL Celery
CRD Chard
CHC Chinese Cabbage
CKP Cucumber-Transplanted
CKS Cucumber-Seeded
EGG Eggplant
END Endive
LET Lettuce
MIX Mixed Vegetables

CODE
MML Muskmelon
MUS Mustard
ONP Onion-Transplanted
ONS Onion-Seeded
PSL Parsley
PSN Parsnips
PEA Peas
PEP Peppers
POP Popcorn
POT Potatoes
PUM Pumpkins

CODE
RAD Radishes
RHU Rhubarb
RUT Rutabagas
SPS Spinach-Spring
SPF Spinach-Fall
SQS Squash-Summer
SQW Squash-Winter
SWC Sweet Corn
TME Tomato-Early
TOM Tomatoes-All others
TUR Turnips
WAT Watermelon

CODE
APP Apples
ACT Apricots
BKB Blackberries
BLB Blueberries
BYB Boysenberries
CHS Cherries, sweet

CODE
CHT Cherries, tart
CUR Currants
DEW Dewberries
ELD Elderberries
GOO Gooseberries
GPA Grapes, American

CODE
GPF Grapes, French-American
GPV Grapes, Vinifera
NEC Nectarines
NUR Nursery Stock
PAR Pears
PCH Peaches

CODE
PLM Plums
PRN Prunes
RSF Raspberries, Fall
RSS Raspberries, Summer
STE Strawberries, Ever
STS Strawberries, Spring

For TREE FRUITS and GRAPES write variety in the THIS CROP section on the front.

CODE
TRT Christmas trees, Topdressing
TRE Christmas trees, Establishment
Write tree species in the THIS CROP section on front

CODE
IDL Idle land

CODE
OTH Other Crops (Not Listed)
Write OTHER CROP name on front.

Forage Production Idea Sheet
Input Management

Ideas I like in this section	What I will do to follow up	Other information I need to follow up

ACTIVITY 7

Putting Manure in its Place

I. Learning Goals of this Activity

1. To understand that with a well managed crop rotation and manure spreading plan that the majority of the crop nutrient needs of a farm can be met through manure.

2. To also understand that corn yields will not be as high without manure and that economics suggest that manure should be applied to any corn fields after the first year and all grass hay fields.

3. To learn to use the Manure Work Sheets that are additions to the Managing Animal Manure Fact Sheets.

II. Key Points

1. Most farms can come close to meeting their crop nutrient needs solely with the use of manure. Nitrogen is the most difficult nutrient to manage, but through careful planning of crop rotation and distribution of the manure even nitrogen requirements can easily be met.

2. One of the largest opportunities to make money is through cost reductions. Manure is viewed as a waste product and typically not used as a resource. The cost of getting rid of this waste is already paid for so for the cost of sitting down and planning where the spreader dumps the fertilizer the bill for the farm could be greatly reduced.

3. The hardest part of crop production may be sitting down and planning, but the next time it's 10 degrees below zero outside it might be a lot easier to sit down and plan while somebody else thaws the water buckets...

SOILS
COOPERATIVE EXTENSION • NEW YORK STATE • CORNELL UNIVERSITY

Page: 100.00
Date: 3–83
Revised 4–85

Managing Animal Manure as a Resource Part I: Basic Principles

by Stuart Klausner and
David Bouldin
Department of Agronomy
Cornell University

The economic value of manure is related to the nutrients it contains, its organic matter content, and probably some unknown enhancement factors that help to improve crop production. Management is the single most important factor that controls utilization of these nutrients by a crop. Proper management will increase economic returns and reduce environmental concerns.

This first fact sheet of a two-part series discusses basic principles concerning the (1) nutrient content of manures, (2) forms and behavior of nitrogen and its effect on crop yield, and (3) use of manure in a soil fertility program. A second fact sheet, entitled *Managing Animal Manure as a Resource. Part II: Field Management,* discusses the management of a land application program and provides examples and work sheets to calculate the quantity of nutrients produced on the farm, to estimate nitrogen availability, and to determine an appropriate rate of application to meet certain nutrient requirements.

Nutrient Production

Approximately 75% of the nitrogen, 60% of the phosphorus, and 80% of the potassium that are fed to a dairy cow are excreted in the manure. Swine and poultry manures show similar returns of nitrogen but contain higher percentages of phosphorus and potassium than from dairy cows. Other nutrients contained in manure include magnesium, calcium, sulfur, and trace amounts of zinc, boron, and other micronutrients. Because of the high nutrient return in manure, there is a great opportunity to recycle plant nutrients from the crop to the animal and back to the crop again.

The quantity of nutrients in manure depends primarily on the (1) feeding program, (2) amount of water added or lost, and (3) method of handling. The nutrient content of manure can vary considerably. A chemical analysis is the most accurate way to determine the nutrient content of manure. Avoid using the average values listed in many publications. They may do more harm than good.

The total weight of manure and the quantity of nitrogen, phosphorus, and potassium produced each year are usually not appreciated until they are calculated. The plant nutrient needs of your farm can be determined with a good soil testing program. When comparing the nutrient requirements of the crop rotation with the quantity of nutrients produced in manure, it will become evident that manure can satisfy much of the nutrient demand of the farm.

Nutrient Value

A crop's utilization of nutrients depends on the management of the land application program, as well as the rate of biological breakdown of the organic material and release of plant-available nutrients. Some background about the nitrogen, phosphorus, and potassium in manures is necessary to fully appreciate their fertilizer replacement value.

Nitrogen

Unlike testing for phosphorus and potassium, there is no quick soil-testing procedure to determine effective nitrogen supply in soils. The nitrogen supply from manure must be estimated from research and applied to the farm.

Because of its chemical nature, the nitrogen in manure is more difficult to manage than the other nutrients. There are two forms of nitrogen (N) in manure: the unstable and the stable organic form (fig. 1). In either form, the organic N must be decomposed by microorganisms before it is available to plants. This decomposition is called *mineralization,* because an organic form is converted to a mineral inorganic form. The inorganic forms are available to the crop as ammonium (NH_4) and nitrate (NO_3).

The unstable organic N is present in urine as urea in cattle and swine manure and as uric acid in poultry manure. It may account for 50 to 60% of the total nitrogen in dairy and swine manure and 70% in poultry manure. Urea in manure is no different from urea in commercial fertilizer.

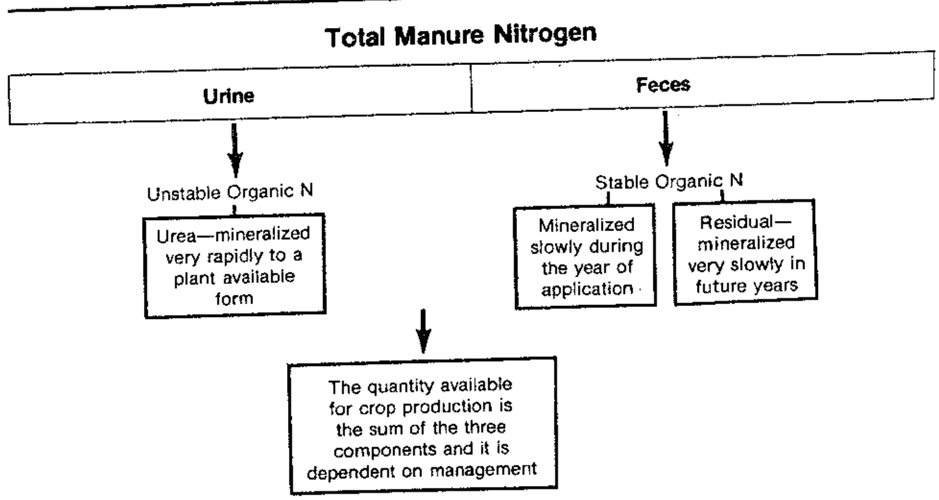


Figure 1. Form and degree of nitrogen availability in manure

Urea or uric acid mineralizes rapidly to plant-available ammonium N and, in turn, converts very rapidly to ammonia N as the pH increases and the manure begins to dry. Ammonia N is extremely volatile, so increased exposure of manure on the barn floor, in storage, or after spreading increases nitrogen loss. Figure 2 shows typical field losses of ammonia N after a broadcast application of dairy manure. If manure is left exposed in the field, about 50% of the total nitrogen can be lost in a relatively short time.

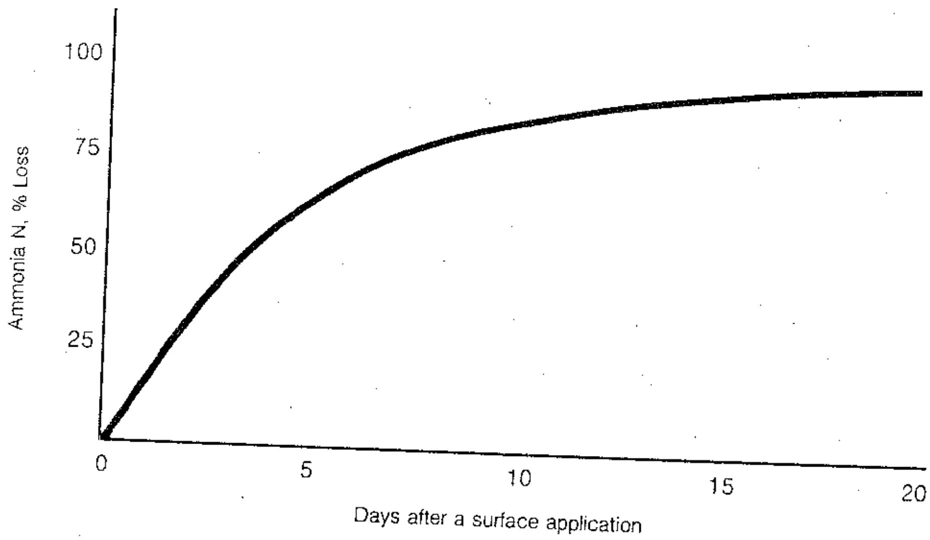


Figure 2. Loss of ammonia N by volatilization after a surface application of dairy manure

Table 1. Corn silage yields at Aurora, New York, in 1979 as influenced by various rates of manure and commercial fertilizer nitrogen

Commercial fertilizer N lb/acre	Manure treatment none	25 tons/acre	75 tons/acre
	--------tons/acre--------		
0	12.5	18.6	20.7
50	18.6	20.2	20.9
100	19.5	20.1	20.7
200	20.3	21.0	20.2

Table 2. Corn silage yields at Chazy, New York, in 1980 as influenced by manure and commercial fertilizer nitrogen

Commercial fertilizer N lb/acre	Manure treatment none	27 tons/acre
	--------tons/acre--------	
0	10.2	20.1
50	15.9	20.9
100	16.8	21.6
200	19.8	21.6

The remaining nitrogen is contained in the feces. It is a more stable and a more slowly released form of organic N than urea. The rate of mineralization to a plant-available form occurs in two phases. The first phase includes the less resistant organic N, which mineralizes during the first year of application. The second phase includes the more resistant residual organic N, which mineralizes very slowly in future years. Repeated yearly applications to the same field result in an accumulation of a slow-release manure N source from present and past applications.

The total amount of nitrogen that is available for crop production in any one year is the amount of ammonium N plus that nitrogen mineralized from organic N from the current manure application plus that mineralized from residual organic N from past applications (see fig. 1).

Manure management has a large effect on how much nitrogen is available for crop production. The economic effects of management can be measured in terms of crop yields or by savings in fertilizer costs. Results from several field trials are given to show the importance of the nitrogen supplied by (1) organic N alone, (2) organic N + ammonium N, and (3) residual organic N from past applications.

In these field trials, manure was applied in alternate strips. Nonmanured strips were included for comparison purposes. Corn was planted and commercial fertilizer N was applied as a sidedressed incorporation on the manured and nonmanured sections of the field at a rate of either 0, 50, 100 or 200 pounds of nitrogen per acre. This was done to determine the fertilizer replacement value of manure N under several management conditions on fields in continuous corn. A starter fertilizer containing 15 pounds of N and adequate amounts of P_2O_5 and K_2O was used.

Case 1: Nitrogen supplied from organic N alone. Usually, manure is not immediately incorporated in the early spring, so most, if not all, of the ammonia is lost prior to crop uptake. In this case, the nitrogen supplied by manure comes primarily from the mineralization of organic N. To measure the importance of this contribution, two experiments were run to evaluate the short- and long-term effects of applying organic N.

Manure was broadcast on a field that had not been manured for at least 25 years. Incorporation of the spring application was delayed to be sure the ammonia was lost. The yields in table 1 show that where no commercial fertilizer N was applied, silage yields increased from 12.5 to 18.6 tons due to an application of 25 tons of manure. This yield increase was the result of the extra nitrogen supplied from the organic N in manure. This rate of manure application did not supply the entire nitrogen requirement of the corn because there was little to no residual organic N from past applications. The problem can be overcome by increasing the application rate, which, in turn, increases the amount of organic N added. When the rate was increased from 25 to 75 tons of manure per acre, the yield goal was satisfied by manure alone.

When manure is spread at more modest rates of application, it must be applied for several years in order to supply the entire nitrogen requirement. Table 2 shows the results of a field trial where manure was applied for 6 consecutive years. Incorporation of the 27 ton per acre spring application was delayed to be sure the ammonia was lost. There was no economic yield increase from adding commercial fertilizer N where manure was applied. The contribution of nitrogen from the residual and currently applied organic N satisfied the crop's requirement.

Case 2: Organic N + ammonium N. The importance of conserving ammonia N is shown in table 3. Over a 4-year period, liquid manure was applied between corn rows when the plants were 8- to 10-inches tall as either a topdressing to encourage ammonia loss, or as a sidedress injection to conserve ammonia. The increase in yield from 9.4 tons of silage without manure to 15.1 tons from topdressing manure resulted from the contribution of nitrogen from organic N. A further yield increase to 19.3 tons of silage by injecting manure was the result of the extra nitrogen contributed by conserving ammonia N.

Conserving ammonia N is only important when the rate of manure applied cannot supply the entire nitrogen requirement from the organic N portion. Applying an excessive rate of nitrogen is wasteful and will not produce higher yields.

Case 3: Residual effects of organic N. When manure is no longer applied to a field, there is a continued supply of nitrogen from residual organic N. The value of the nitrogen during the first residual year can be high, but it diminishes rapidly in future years as more and more resistant organic N is encountered.

The residual effect of nitrogen from past applications is shown by the yields in table 4. In this experiment, one-third of the field did not receive any manure, one-third received manure annually for 4 years, and the last third had manure applied for the past 6 years. Corn yields were measured to determine the value of the nitrogen, supplied from previous applications, during the first and third year after the manure applications stopped. There was only a small increase in yield due to adding fertilizer N during the first residual year. By the third residual year the fertilizer N requirement was about the same as if manure had not been applied.

The conclusion from these experiments is that the value of nitrogen in manure as a replacement for commercial fertilizer N depends on the rate of application, the degree of ammonia conservation, and the number of years the manure has been applied. Each condition can be compensated for by adjusting the management of the others.

Table 3. Corn silage yields at Chazy, New York, in 1978 as influenced by the method of manure application and rate of commercial fertilizer nitrogen

Commercial fertilizer N lb/acre	Manure treatment		
	none	4500 gal/acre topdressed	4500 gal/acre injected
	--------tons/acre--------		
0	9.4	15.1	19.3
50	16.6	18.7	
100	20.4	20.4	
200	20.3	22.1	

Table 4. Corn silage yields at Chazy, New York, in 1981 as influenced by the residual effects of manure

Commercial fertilizer N lb/acre	Manure treatment		
	none	1st year residual	3rd year residual
	--------tons/acre--------		
0	14.3	22.8	16.1
50	19.3	23.7	21.4
100	22.9	24.7	23.5
200	23.7	24.0	24.8

Phosphorus and Potassium

Manure is an excellent source of phosphorus (P) and potassium (K). When manure is applied over a long period of time or at a high application rate, these nutrients will accumulate in the soil. Essentially all of the potassium is available during the year applied. On the other hand, some of the phosphorus is present as relatively insoluble inorganic compounds or as organic P which, like organic N, must mineralize before it is available.

There are well-established soil testing procedures to determine the effective phosphorus and potassium supply in soils. Fields that are manured regularly will generally test in the medium to high range. At high soil-test levels, it is not economical to apply additional P and K in fertilizer or manure except for a banded starter fertilizer with the planter.

Soil Fertility

The first priority of a well-managed land application program is to develop a soil fertility program that ensures that manure is used as the basis for supplying plant nutrients. Commercial fertilizer should be used only to supplement additional needs. A particular kind of manure-handling system does not, in itself, increase or decrease nutrient utilization by a crop—management does.

The loss of nitrogen can be substantial if the manure is not immediately incorporated into the soil. Although incorporation will prevent ammonia volatilization, a late summer or fall incorporation will result in nitrogen losses from leaching and denitrification (an additional gaseous loss of nitrogen) before the next growing season. Some mineralization of the nitrogen in fall-applied manure will occur and result in a loss of organic N. Fall and winter applications increase the risk of nutrient runoff or erosion of freshly worked soil if the manure is incorporated. Immediate incorporation in the spring or early summer provides for maximum conservation of nutrients. If manure is applied in excess of crop needs, some loss of nutrients is unimportant as far as yield is concerned. Environmental enrichment, however, should be kept to a minimum.

To manage nutrients in manure efficiently, it is desirable to have an analysis of the manure, an estimation of its nutrient availability, and a soil test to determine the nutrient requirements of the crop.

Manure Analysis

A minimum manure analysis should include the percentage of dry matter, ammonium N (NH_4N), total N (NH_4N + organic N), phosphorus (P or P_2O_5) and potassium (K or K_2O). The manure sample must be representative. Small subsamples taken over a period of time for daily spreading programs, from several locations in a manure pack, or from several samplings from a well-agitated liquid storage should be composited for analysis. Place sample in a plastic bottle, seal tightly and follow the instructions provided by the laboratory.

Nutrient Availability

Nitrogen. All of the ammonium N in manure is available. The amount utilized by the crop depends entirely on how the manure is managed during handling and application. Determining the availability of the organic N is more complex, because results can vary depending on the soil and climate.

A reasonable estimate can be made by using a decay series to calculate the rate of organic N mineralization from the present and previous applications. The decay series that is suggested for New York for a relatively fresh manure is .40-.12-.05-.02. This means that 40% of the organic N is mineralized during the year it is applied, 12% of the initial organic N applied is mineralized the second year, 5% of the initial organic N applied is mineralized the third year, and 2% is mineralized during the fourth and future years.

With this decay series, if 100 pounds of organic N were applied per acre per year, the nitrogen mineralized during the first year would be 40 pounds (40% x 100); the second year it would be 40 pounds from the second application (40% x 100) plus 12 pounds from the first application (12% x 100) for a total of 52 pounds. The third year, the amount of nitrogen mineralized would be 40 (40% x 100) plus 12 (12% x 100) plus 5 (5% x 100) for a total of 57 pounds. The fourth and future years are calculated in a similar fashion.

A work sheet is provided in Part II of this fact sheet series to help you with this decay series calculation.

Phosphorus and Potassium. The availability or effectiveness of phosphorus and potassium in manured fields should be measured by soil testing. A good management practice is to soil sample on a regular basis and follow Cornell's recommendations for the P_2O_5 and K_2O fertilizer requirement.

Application

The rate of application should be based on the capacity of the crop to utilize the applied nutrients. The ratio of N to P_2O_5 to K_2O in manure usually does not match the ratio of the nutrients needed by the crop; therefore, complete utilization is impossible. An appropriate rate can be calculated by basing it on the nutrient availability of the manure and the crop requirement for the nutrient having the highest priority.

An excessive rate of application may cause plant toxicity or water pollution problems. Manure can contain appreciable amounts of ammonium, which may create toxic levels of ammonia in the soil if manure is immediately incorporated just before planting. This is usually more of a problem with poultry than livestock manure. Lowered germination and poor seedling vigor can occur. Delaying planting for a week or more after application will usually solve the problem.

All attempts should be made to keep nutrient levels in surface and ground waters to a minimum. Aquatic growth in surface water and high nitrate levels in potable water are some of the more common problems. Nutrient loadings into surface and ground waters should be controlled with the appropriate soil and water conservation practices and by managing the timing and rate of manure application.

Suggestion

Refer to a second fact sheet entitled *Managing Animal Manure as a Resource. Part II: Field Management.* It will help you apply these basic principles to practical situations. It also contains examples and work sheets to organize the information needed to apply manure and commercial fertilizer at a rate that is economical and beneficial.

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anaging Animal Manure

ork Sheet No. 1. Estimating the quantity of manure, nitrogen, phosphate, and potash produced each year

xample: A dairy farm has 75 cows and 50 heifers. The average weight of a cow is 1300 lbs. and heifers average 500 lbs. Manure is handled as a nonliquid.
alculate the amount of manure and quantity of N, P2O5, and K2O produced annually.

Calculations	*Example*	Your Farm
Determine the number of 1000 lb. animal units.		
a. Total weight = no. of animals x weight per animal	*(75 cows x 1300 lbs.) = 97,500 lbs.* *+(50 heifers x 500 lbs.) = 25,000 lbs.* *122,500 lbs.* *122,500 lbs.*	______ lbs.
b. Animal units = total weight ÷ 1000 lb. per unit	*122,500 ÷ 1000 = 122.5 units*	______ units
2. Determine the quantity of manure produced or collected annually.		
Quantity = tons or gal per animal unit from Table 1° x number of animal units	*15 tons x 122.5 unit = 1837 tons*	______ tons
Quantity = amount in storage x 12 ÷ months of storage		______ gals
3. Determine the nutrient value of the manure. Insert the nutrient value of manure from a recent analysis Express as lb. per ton for nonliquid system or as lb. per 1000 gal. for a liquid system.	*N = 10 lbs/ton* *P2O5 = 5 lbs/ton* *K2O = 9 lbs/ton*	N = ______ lbs/year P2O5 = ______ lbs/year K2O = ______ lbs/year
4. Determine the quantity of N, P2O5, and K2O produced or collected annually. Liquid system lb. per yr. = gal. per yr. from item 2 ÷ 1000 x lb. per 1000 gal. from item 3. Nonliquid system lb. per yr. = tons per yr. from item 2 x lb. per ton from item 3.	*N = 18370 lbs/yr* *P2O5 = 9185 lbs/yr* *K2O = 16533 lbs/yr*	N = ______ lbs/ton P2O5 = ______ lbs/ton K2O = ______ lbs/ton

°From Cornell Cooperative Extension Agronomy Fact Sheet: Managing Animal Manure as a Resource Part II: Field Management (15 tons/1000 lb. dairy unit).

Managing Animal Manure

Work Sheet No. 2. Estimating the amount of nitrogen available for crop production.

Example: A dairy manure sample was taken from a nonliquid storage facility and analyzed. The following calculations show how to estimate the amount of nitrogen that will be available during the growing season from the current manure application and from previous applications. Assume that 25 tons/acre having an organic N content of 6 lb/ton, were applied each of the past 3 years.

Calculations

A. Insert the percentage of dry matter and the nitrogen value of the manure from the analysis in lb per ton for a nonliquid system of lb per 1000 for a liquid system. Organic N = Total N – Ammonium N.

	Example	Your Farm
Dry Matter	*15%*	
Total N°	*10 lb/ton*	
Ammonium N	*4 lb/ton*	
Organic N°	*6 lb/ton*	

B. Determine the availability of nitrogen during the first year. Available N = lb of ammonium N or organic N in item x the percentage of availability from figure B°°.

	Time of Application	Ammonium N (lb x %)		Organic N (lb x %)		Available N
		Quantity available from				
Example:	*Fall*	*4 x 0*	+	*6 x .35*	=	*2.1 lb/ton*
	Sp. 2 day delay	*4 x .35*	+	*6 x .35*	=	*3.5 lb/ton*
	Sp. immed.	*4 x .65*	+	*6 x .35*	=	*4.7 lb/ton*
Your Farm:						
Field #			+		=	
Field #			+		=	
Field #			+		=	
Field #			+		=	
Field #			+		=	

C. Determine the availability of nitrogen from previous applications. Omit those years when manure was not applied. Available N per acre = application rate from previous records in tons or 1000s of gal x lb of organic N per ton per 1000 gal x percentage of availability from figure B°°.

	1 year ago (rate x N x %)		2 years ago (rate x N x %)		3 years ago (rate x N x %)		Residual N availability
	Quantity available from residual organic N from:						
Example:	*25 x 6 x .12*		*25 x 6 x .05*		*25 x 6 x .02*		*28.5 lb/A*
Your Farm:							
Field #		+		+		=	
Field #		+		+		=	
Field #		+		+		=	
Field #		+		+		=	
Field #		+		+		=	

°Some laboratories may report their nitrogen results under the heading "nitrogen and "ammonium or ammonia N". The larger of the two numbers is total N. Many laboratories do not report organic N simply because it is the difference between total N and ammonium N.

°°From Cornell Cooperative Extension Publication: Field Crop and Soils Handbook.

Managing Animal Manure

Work Sheet No. 3. Estimating a Rate of Application

Example: A dairy operator will apply manure to a 15 acre cornfield in the fall. From the manure analysis and available N calculations in work sheet 2. Determine the rate of application to meet the N requirement, the amount of P2O5 and K2O added, the amount of commercial fertilizer needed.

Calculations		*Example*	Field #	Field #	Field #	Field #	Field #
A. Determine the current needs of the crop.							
1. Crop to be grown		*Corn*					
2. Nutrient requirements from the Cornell soil test		N = *120 lb/A* P2O5 = *30 lb/A* K2O = *20 lb/A*					
B. Determine the nutrient value of manure. *Express as pounds per ton for a nonliquid system or pounds per 1000 gallons for a liquid system.*							
1. Available N from item B in work sheet 2		N = *2.1 lb/ton*					
2. P2O5 from recent analysis		P2O5 = *5 lb/ton*					
3. K2O from recent analysis		K2O = *9 lb/ton*					
C. Determine the rate of application							
1. Nutrient having the highest priority.		= *N*					
a. *Amount to be supplied by manure. Express as pounds needed in item A.2 minus amount of fertilizer applied.*	120 lb – 30 lb at planting	= *90 lb/A*					
b. If nitrogen, subtract residual N availability from item C in work sheet 2	90 lb – 28 lb/A residual	= *62 lb/A*					
2. Rate of manure needed to supply highest priority nutrient (item C.1 ÷ item B). *Express in tons per acre for a nonliquid system or as 1000s of gallons per acre for a liquid system.*	62 lb/A ÷ 2.1 lb/ton	= *30 ton/A*					
3. Pounds of N, P2O5, and K2O applied per acre with manure							
a. N value from item B.1 x manure rate from item C.2 + residual N availability from item C work sheet 2.	*(2.1 lb/ton x 30 tons) + 28 lb*	N = *90 lb/A*					
b. P2O5 value from item B.2 x manure rate from item C.2.	*(5 lb/ton x 30 tons)*	P2O5 = *150 lb/A*					
c. K2O values from item B.3 x manure rate from item C.2.	*(9 lb/ton x 30 tons)*	K2O = *270 lb/A*					
D. Determine the amount of commercial fertilizer needed.	*120 lb – Manure 90 lb* *Based on soil test* *Based on soil test*	N = *30 lb/A* P2O5 = *30 lb/A* K2O = *20 lb/A*					

Managing Animal Manure

Work Sheet No. 4. Determine the number of manure spreader loads required to apply the application rate in C.2, Work Sheet 3.

Example: Continued from Work Sheet 3.

Calculations	*Example*	*Field #*	*Field #*	*Field #*	*Field #*	*Field #*
1. Spreader Capacity (use equations from Table 1)						
a. Liquid System (Express in units of 1000s of gal per load)		___	___	___	___	___
b. Nonliquid system; cut off spreader =	16.9' x 6.3' x 3.2' = *340 ft3*	___	___	___	___	___
tons per load =	340 ft3 x 62 lb/ft ÷ 2000 = *10.5 tons.load*	___	___	___	___	___
2. Numbers of loads needed						
a. Loads per acre = manure rate in C.2 ÷ spreader capacity from Table 1.	*30/10.5 = 2.9 loads/A*	___	___	___	___	___
b. Loads per field = loads per acre x acres	*2.9 x 15 = 44 loads*	___	___	___	___	___

Table 1. Approximate manure spreader capacities

Nonliquid System

Spreader Volume (Measure all dimensions in feet and tenths of feet.)

Box spreader: cubic feet = length x width x average depth.

Barrel spreader: cubic feet = 0.303 x d2 (diameter squared) x length.

Irregular shapes: Use manufacturer's rated capacity. Estimate the percentage of a full load.

Spreader capacity

Tons per load = $\frac{\text{cubic feet x 62 lb cubic feet}}{\text{2000 lb per}}$ (Use 55 lb per cubic feet) for extremely dry manure

Liquid system

Tank spreader: Use manufacturer's data to determine gallon capacity. Estimate the percentages of a full load. There are approximately 8300 lb in 1000 gal.

Forage Production Idea Sheet
Putting Manure in its Place

Ideas I like in this section	What I will do to follow up	Other information I need to follow up

ACTIVITY 8

Completion Windows for Spring Field Operations

I. Learning Goals of this Exercise

1. To learn that having an objective to plant crops and harvest first cutting earlier in the spring requires a considerable amount of planning to fulfill. The time required for spring crop work can be estimated and the impacts of changing labor inputs and machinery can also be estimated.

2. To learn how to actually estimate the time that will be required to complete spring planting and forage harvest and, based on typical weather, when they can start and expect to finish spring crop work.

3. After completing the exercise, have a much better understanding of why it is so difficult to complete the planting of crops by recommended dates. To better understand the impact of weather and soils on soil tillage and crop planting schedules.

II. Key Points

1. The timeliness with which spring hay seeding and corn planting can be completed has an effect on the time for initiation of first cutting of hay crop. If seedings or plantings are delayed, the hay crop may be past optimum maturity at harvest and thus be of lower quality. This is a second cost as late planting costs in yield and possibly quality also.

2. The date at which seedings and plantings are completed depends on the acreage involved, the machine capacities, availability of labor, the soil resources in terms of drainage and how early it can sustain field work, and the weather.

3. Farm managers have control over several of the inputs listed in item 2. Just because they do not control the weather does not mean planning is not in order. The well managed farm is prepared for good weather and is not caught preparing when the weather breaks. In addition, the well managed farm is prepared for bad weather and makes plans to minimize its impacts.

4. The data used for spring field work probabilities is only an estimate based on many years of weather data and soils research. The probabilities may need to be adjusted, based on experience, to a given farm. This is a planning tool and in no way can be used to predict weather in a given year.

5 To harvest high quality forage the whole spring crop work schedule has to be planned from tillage, to planting, to cutting hay.

Machinery Operation Time Work Sheet

$$\underline{\text{Time Required}}\ (\text{hours/acre}) = \frac{8.25}{\underset{(\text{feet})}{\text{Width of Machine}} \times \underset{(\text{m.p.h.})}{\text{Speed}} \times \underset{(\text{decimal})}{\text{Field Efficiency}}}$$

Field Efficiency = Percentage of theoretical field efficiency actually accomplished

Example 1: Plowing

Width = 8 feet
Speed = 4.0 m.p.h.
Field Efficiency = 80% or 0.80

$$\text{Time Required} = \frac{8.25}{8 \times 4.0 \times 0.80} = 0.32 \text{ hours/acre}$$

Example 2: Harrow

Width = 12 feet
Speed = 5 m.p.h.
Field Efficiency = 80% or 0.80

$$\text{Time Required} = \frac{8.25}{\quad \times \quad \times \quad} = \underline{\qquad\qquad} \text{ hours/acre}$$

Field Machinery Summary Table

Implement	Operating Width (feet)	Speed (mph) Typical	Speed (mph) Range	Speed (mph) My Farm	Field Efficiency Typical	Field Efficiency Range	Field Efficiency My Farm	Hours/Acre
Moldboard		4.0	(3.0–6.0)		0.80	(.70–.90)		
Disc		4.0	(3.0–6.0)		0.80	(.70–.90)		
Chisel Plow		5.0	(4.0–6.5)		0.80	(.70–.90)		
Powered Rotary Tiller		3.0	(2.0–4.0)		0.80	(.70–.90)		
Harrow		4.5	(3.0–6.0)		0.80	(.70–.90)		
Rotary Hoe		7.5	(5.0–10.0)		0.80	(.70–.85)		
Field Cultivator		5.5	(3.0–8.0)		0.80	(.70–.90)		
Field Sprayer		4.0	(3.0–5.0)		0.65	(.50–.80)		
Corn or Soybean Planter		4.5	(3.0–6.0)		0.70	(.50–.85)		
No–Till Corn Planter		4.0	(2.5–5.5)		0.70	(.50–.85)		
Grain Drill		4.2	(2.5–6.0)		0.65	(.60–.85)		
Land Roller		6.0	(4.5–7.5)		0.75	(.70–.90)		
Row Crop Cultivator		3.5	(2.0–5.0)		0.80	(.70–.90)		

Hours Required for Corn Planting
My Farm

Operation	Machine Width (ft)	Hours equired per Acre Hours
____________	________	________
____________	________	________
____________	________	________
____________	________	________
____________	________	________
____________	________	________
____________	________	________

Total Field Operations Time (hours/acre) ____________

Number of Acres ____________

Total Hours = (acres) x $\frac{\text{hours}}{\text{acre}}$ ____________

Hours Required for Spring Hay Seeding
My Farm

Operation	Machine Width (ft)	Hours Required per Acre Hours

Total Field Operations Time (hours/acre) ____________

Number of Acres ____________

Total Hours = (acres) x $\frac{\text{hours}}{\text{acre}}$ ____________

Soil Multiplication Factors
My Farm

Soil Drainage Class	Number of acres	÷	Total acres	=	Multiplication factors
Well-drained	________	÷	____	=	____________
Mod. well-drained	________	÷	____	=	____________
Somewhat poorly drained	________	÷	____	=	____________

Total acres ________

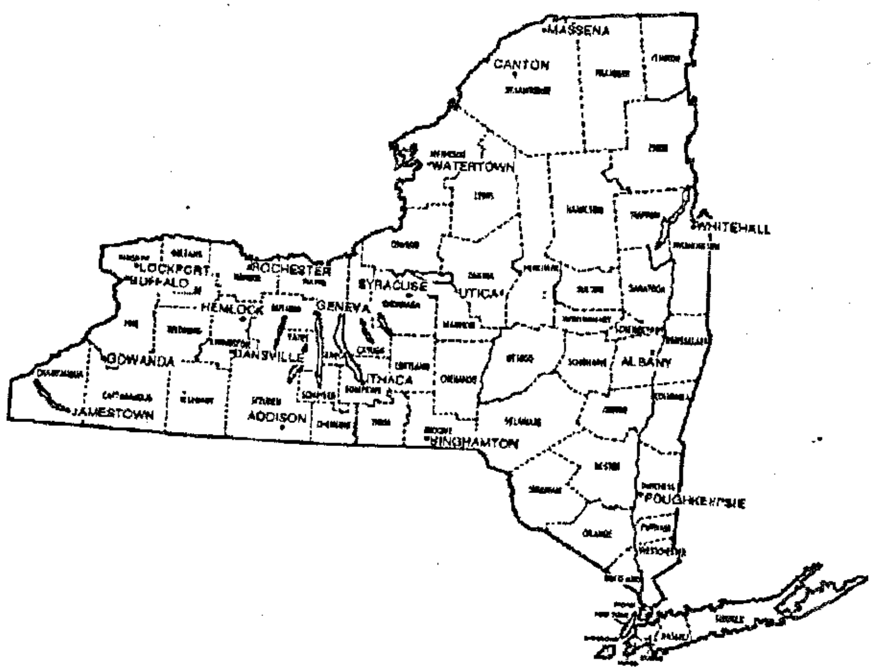
Spring Field Work Probabilities

Location	Week/Suggested Calendar Week							
	1 4/12-18	2 4/19-25	3 4/26-5/2	4 5/3-9	5 5/10-16	6 5/17-23	7 5/24-30	8 5/31-6/6
	(Probabilities expressed as percent)							
Addison								
Well-drained soils	6	12	19	25	31	38	38	56
Mod. well-drained soils	1	6	6	6	18	31	31	31
Somewhat poorly drained soils	1	1	1	1	1	12	25	31
Albany								
Well-drained soils	5	7	28	30	33	44	70	74
Mod. well-drained soils	1	2	5	16	21	30	40	58
Somewhat poorly drained soils	1	1	2	5	14	21	30	35
Binghamton								
Well-drained soils	3	15	15	28	28	41	54	64
Mod. well-drained soils	1	3	13	13	18	28	38	51
Somewhat poorly drained soils	1	1	3	5	10	18	28	38
Buffalo								
Well-drained soils	1	5	21	26	30	53	64	84
Mod. well-drained soils	1	1	5	14	26	28	47	65
Somewhat poorly drained soils	1	1	1	5	14	26	26	47
Canton								
Well-drained soils	1	2	5	7	19	29	43	67
Mod. well-drained soils	1	1	1	2	4	17	26	43
Somewhat poorly drained soils	1	1	1	1	2	4	17	26
Dansville								
Well-drained soils	1	1	20	27	33	47	47	67
Mod. well-drained soils	1	1	1	13	13	27	33	40
Somewhat poorly drained soils	1	1	1	1	7	13	27	27
Geneva								
Well-drained soils	1	9	21	24	44	56	68	74
Mod.well-drained soils	1	1	6	12	26	41	47	59
Somewhat poorly drained soils	1	1	1	3	12	24	35	44
Gowanda								
Well-drained soils	1	6	12	12	25	56	69	75
Mod.well-drained soils	1	1	1	6	12	19	44	62
Somewhat poorly drained soils	1	1	1	1	1	6	19	38
Hemlock								
Well-drained soils	1	5	21	26	33	44	49	67
Mod.well-drained soils	1	1	5	10	23	31	36	44
Somewhat poorly drained soils	1	1	1	3	10	18	26	33

Spring Field Work Probabilities
(continued)

Location	Week/Suggested Calendar Week 1 4/12-18	2 4/19-25	3 4/26-5/2	4 5/3-9	5 5/10-16	6 5/17-23	7 5/24-30	8 5/31-6/6
	(Probabilities expressed as percent)							
Ithaca								
Well-drained soils	1	3	13	18	29	42	55	58
Mod.well-drained soils	1	1	3	11	11	26	37	45
Somewhat poorly drained soils	1	1	1	3	8	8	24	37
Jamestown								
Well-drained soils	1	8	19	27	35	41	62	86
Mod.well-drained soils	1	1	3	10	18	21	26	38
Somewhat poorly drained soils	1	1	1	1	10	15	15	23
Lockport								
Well-drained soils	1	8	19	27	35	41	62	86
Mod.well-drained soils	1	1	8	19	24	24	35	62
Somewhat poorly drained soils	1	1	1	8	16	19	22	35
Massena								
Well-drained soils	1	1	19	25	50	50	69	75
Mod.well-drained soils	1	1	1	6	25	44	44	69
Somewhat poorly drained soils	1	1	1	1	6	19	44	44
Poughkeepsie								
Well-drained soils	6	17	25	36	44	47	69	83
Mod.well-drained soils	3	6	14	25	33	39	42	69
Somewhat poorly drained soils	1	3	3	11	19	31	39	42
Rochester								
Well-drained soils	1	10	27	33	36	54	52	74
Mod.well-drained soils	1	1	10	21	23	33	49	59
Somewhat poorly drained soils	1	1	1	8	15	23	31	46
Syracuse								
Well-drained soils	1	5	21	21	30	44	56	77
Mod.well-drained soils	1	1	5	14	16	26	40	53
Somewhat poorly drained soils	1	1	1	5	12	14	26	37
Utica								
Well-drained soils	1	1	12	19	25	44	50	81
Mod.well-drained soils	1	1	1	6	12	25	31	44
Somewhat poorly drained soils	1	1	1	1	6	12	25	25
Watertown								
Well-drained soils	1	8	11	16	26	47	53	82
Mod.well-drained soils	1	1	3	8	8	24	42	53
Somewhat poorly drained soils	1	1	1	3	3	8	24	42
Whitehall								
Well-drained soils	1	5	19	24	38	48	57	71
Mod.well-drained soils	1	1	5	14	14	33	43	57
Somewhat poorly drained soils	1	1	1	5	10	14	33	43

Weather Data Station



Spring Field Work Probabilities
My Farm

Location: ____________

Week	Soil Drainage Class	Field Work Probability (Table/100)	x	Multiplication Factors My Farm	=	Product	Sum of Products for Each Week
1	well						
	mod.						
	poor						
2	well						
	mod.						
	poor						
3	well						
	mod.						
	poor						
4	well						
	mod.						
	poor						
5	well						
	mod.						
	poor						
6	well						
	mod.						
	poor						
7	well						
	mod.						
	poor						
8	well						
	mod.						
	poor						

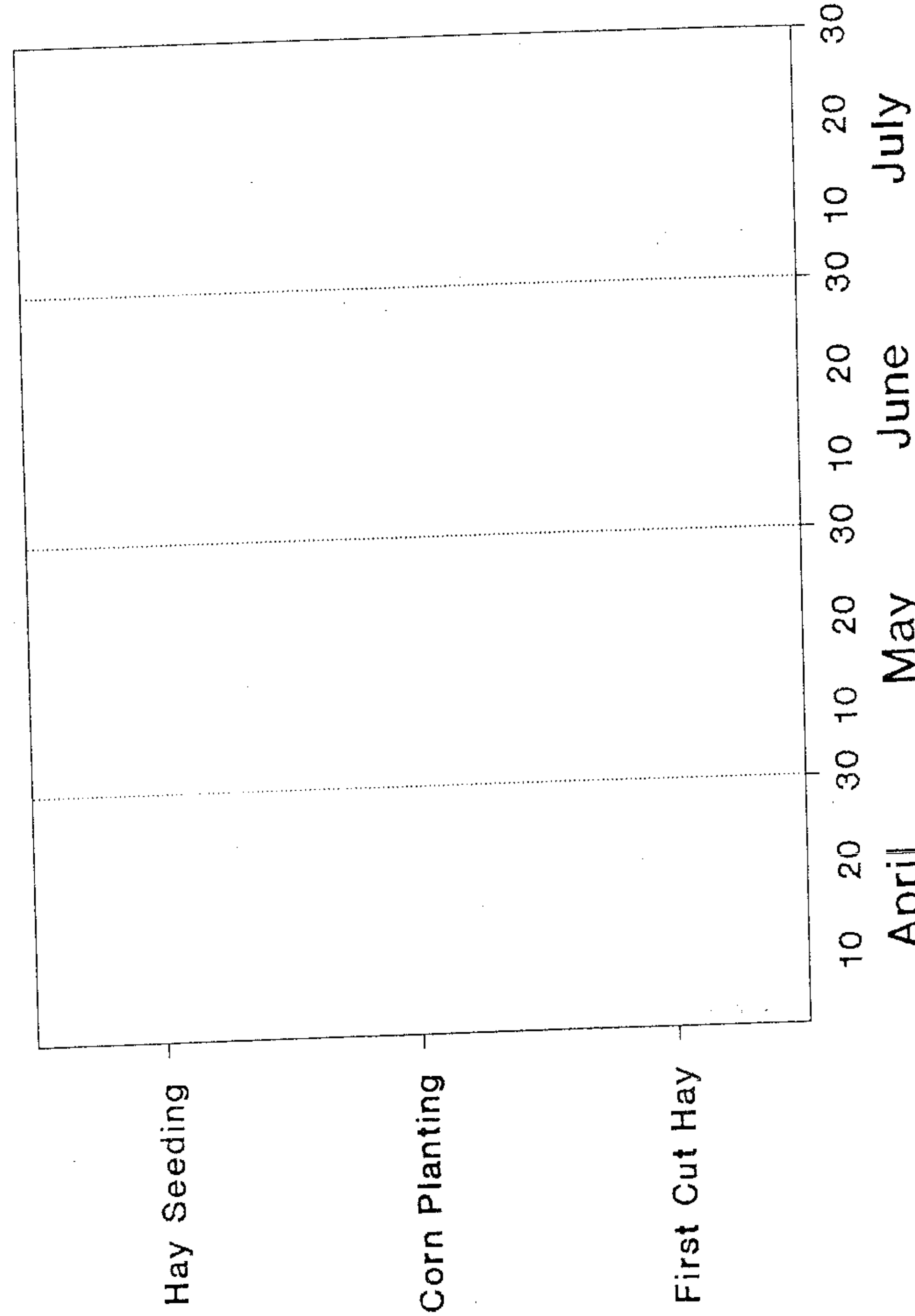
Expected Completion Window, All Planting
My Farm

Week	Dates	Labor Available, hours/day	x	Work Days per Week	x	Field Work Probability	=	Expected Field Work Hours/Week	=	Cumulative Field Work Hours
1	4/12-4/18	________	x	________	x	________	=	(+) ________	=	________
2	4/19-4/25	________	x	________	x	________	=	(+) ________	=	________
3	4/26-5/2	________	x	________	x	________	=	(+) ________	=	________
4	5/3-5/9	________	x	________	x	________	=	(+) ________	=	________
5	5/10-5/16	________	x	________	x	________	=	(+) ________	=	________
6	5/17-5/23	________	x	________	x	________	=	(+) ________	=	________
7	5/24-5/30	________	x	________	x	________	=	(+) ________	=	________
8	5/31-6/6	________	x	________	x	________	=	(+) ________	=	________

Total hours required for seeding plus planting = ____________

Expected completion window = ____________

SPRING WORK CALENDAR



Forage Production Idea Sheet
Completion Windows for Spring Field Operations

Ideas I like in this section	What I will do to follow up	Other information I need to follow up

Homework

Pest Problems Quiz and Hay and Silage Preservation and Storage Self Evaluation.

I. Self Evaluation

1. Please complete the two self evaluations prior to the next class and bring them with you. The Pest Problem Quiz will be turned in.

II. Integrated Pest Management

1. It is important that you have a basic understanding of Integrated Pest Management (IPM) principles and practices to enhance your learning experience in the last class. Please read the folowing material that is contained in the resource section of the notebook.

   - A Strategy to Optimize Pest Control Decision - Making for Field Crops and Dairy Cattle.
   - The IPM section in the Cornell Field Crops and Soils Handbook.
   - The pest sections on alfalfa in the handbook and in the current Cornell Recommends for Field Crops.

Hay and Silage Storage and Preservation

Self Examination

1. Am I satisfied with the split between hay and haylage production on my farm?

2. Do I think there are significant changes or losses taking place between the standing crop and the forage delivered to the animal? Have I forage tested both before cutting and after storage of the same material?

3. What are the target moisture levels for removing forage from the field for hay or haylage production?

4. By what means is the moisture content determined for either hay or haylage production? Does the method seem accurate?

5. About what percent of the time does my forage get rained on during field curing?

6. Does the complement of storage facilities on the farm seem either too small or too large?

7. Am I able to leave the silos closed two weeks before unloading them, as recommended for maximum preservation?

8. Is soluble protein of hay crop silage a concern?

9. Is there enough flexibility so that the high and low quality forage can be stored separately and accessed when needed?

10. Do the unloading rates from the silos seem fast enough in the summer months to stay ahead of surface spoilage?

11. Have alternative silage storage facilities been considered (bags, bunkers, etc.)?

12. Do you use or have you considered using hay or silage preservatives? If you are using one, what are your objectives for it and does it seem to be fulfilling them?

Pest Problem Quiz

Date: ______

Grower Name: ____________________

Workshop Site: ____________________

Please fill in the table below by answering the following questions:

1.) What are the major pest problems encountered in alfalfa and field corn on your farm? (Mention insects, weeds and diseases.)

2.) How do you identify when a problem exists?

3.) What factors prompt you to action?

4.) What management strategies do you employ to handle the problem?

5.) How do you measure the success or failure of the treatment program?

1. Pest	2. Identification	3. Action Prompt	4. Management Strategy	5. Measurement of Effectiveness

ACTIVITY 9

Completion Windows for First Cutting

I. Learning Goals of this Exercise

1. To learn that having an objective to harvest first cutting earlier in the spring requires a considerable amount of planning to fulfill. The time required for harvesting and the impacts of changing labor inputs and machinery can be estimated.

2. To learn how to actually estimate the time that will be required to complete the forage harvest based on typical weather.

3. After completing the exercise, have a much better understanding of why it is so difficult to complete first cutting by recommended dates.

II. Key Points

1. The timeliness with which spring hay seeding and corn planting can be completed has an affect on the time for initiation of first cutting of hay crop. If seedings or plantings are delayed, the hay crop may be past optimum maturity at harvest and thus be of lower quality.

2. The date when first cutting is completed depends on the acreage involved, the machine capacities, availability of labor, the soil resources, and the weather.

3. Just because farm managers do not control the weather does not mean planning is not in order. The well managed farm is prepared for good weather and is not caught preparing when the weather breaks. In addition, the well managed farm is prepared for bad weather and makes plans to minimize its impacts.

4. To harvest high quality forage the whole spring crop work schedule has to be planned from tillage, to planting to cutting hay.

Time Reduction: Weather

During first 15 days in June, 2 out of 3 days are suitable for field work. 1 out of 3 may be suitable for baling.

Machinery Repair and Maintenance

Machine	Date Inspected	Repairs Required	Date Repaired	Next Maintenance Needed	Maintenance Completed (Date)	Comments

Calculated Field Capacity
Work Sheet

$$\underset{\text{acres/hour}}{\underline{\text{Field Capacity}}} = \frac{\text{Width of Machine (feet)} \times \text{Machine Speed (m.p.h.)} \times \text{Field Efficiency (decimal)}}{8.25}$$

Field Efficiency = Percentage of theoretical field efficiency actually accomplished

<u>Example 1</u>: Mower Conditioner

Width = 9 feet
Speed = 5.0 m.p.h.
Field Efficiency = 70% or 0.70

$$\text{Field Capacity} \quad \frac{9 \times 5.0 \times 7.0}{8.25} = 3.8 \text{ acres/hour}$$

<u>Example 2</u>: ake

Width = 9 feet
Speed = 4.5 m.p.h.
Field Efficiency = 70% or 0.70

$$\text{Field Capacity} \quad \frac{\_\_\_ \times \_\_\_ \times \_\_\_}{8.25} = \_\_\_\_\_ \text{ acres/hour}$$

Machinery Operation Time Required Work Sheet

Time equired (hours/acre) = 1.0 / Field Capacity (acres/hour)

Example 1: Mower-Conditioner

Field Capacity = 3.8 acres/hour

Time equired (hours/acre) 1.0 / 3.8 = 0.26 hours/acre

Example 2: rake

Field Capacity = 3.4 acres/hour

Time equired (hours/acre) 1.0 / ________ = ____________

Field Machinery Summary Table

Implement	Operating Width (feet)	Speed (mph) Typical	Speed (mph) Range	Speed (mph) My Farm	Field Efficiency Typical	Field Efficiency Range	Field Efficiency My Farm	Hours/Acre
Mower Conditioner		5.0	(4.0–6.0)		0.75	(.60–.85)		
Rake		4.5	(4.0–5.0)		0.75	(.70–.85)		
Baler		3.5	(2.0–5.0)		0.70	(.60–.85)		
Pull Silage Chopper		3.0	(2.0–5.0)		0.60	(.50–.75)		
Self–propelled Chopper		3.5	(2.0–5.0)		0.65	(.60–.80)		
Combine		3.0	(2.0–4.0)		0.70	(.65–.80)		
Corn Picker		2.5	(2.0–4.0)		0.65	(.60–.75)		

Hours Required For Hay Harvest

Operation	Baled Hay	Hay Crop Silage
	---------- hours per acre ----------	
____________	____________	____________
____________	____________	____________
____________	____________	____________
____________	____________	____________
____________	____________	____________
____________	+ ____________	+ ____________
Total Field Operations Time	= ____________	= ____________
Time to Store and Haul/acre	+ ____________	+ ____________
Total Time per acre	= ____________	= ____________

Total Acres	x ______	acres	x ______
Total Hours	= ______	hours	= ______

Total Hay Crop (first cut) ______

Labor Hours Available

Person	Hours/Day	x	Days/Week	=	Hours/Week
______	______	x	______	=	______
______	______	x	______	=	______
______	______	x	______	=	______
______	______	x	______	=	______
______	______	x	______	=	______
______	______	x	______	=	______
______	______	x	______	=	______
______	______	x	______	=	______
______	______	x	______	=	______
______	______	x	______	=	______
			Total Hours/Week	=	______

Total Hours/Week	÷	Days/Week Activity Conducted	=	Hours/Day Available
______	÷	______	=	______

Forage Production Idea Sheet
Completion Windows for Spring Field Operations

Ideas I like in this section	What I will do to follow up	Other information I need to follow up

ACTIVITY 10

Harvest and Storage Management

I. Learning Goals of this Activity

1. To reflect on whether or not the farm has significant problems with harvest and storage management of forages and note what areas need future attention

2. To realize that harvest and storage management is a complicated subject which to understand well would require attending a course just on that subject.

II. Key Points

1. None of the PRO-DAIRY courses deals with the importance of management to the changes in the quantity and quality of forage during preservation and storage. PRO-DAIRY also does not address the management associated with allocation of forages to the various storage structures so that there is access to the high and low quality forage put up by the farmer, or the matching of animal needs to the form and capacity of the storage structures. However, these are important management issues in the success of the dairy farm.

2. Given the time constraints, this course can only bring these issues to the minds of the participants without giving them the actual tools for analyzing or for planning to improve their situation. The questions in this self examination are meant to address common sources of degradation in forage quality and quantity in the preservation process.

Forage Production Idea Sheet
Harvest and Storage Management

Ideas I like in this section	What I will do to follow up	Other information I need to follow up

ACTIVITY 11

Is There Gold in Those Pastures?

I. Learning Goals of this activity

1. To increase awareness of the potential value of pasture in lowering costs of production and feeding.
2. To learn basic pasture management and techniques specific to dairy production.
3. To complete a basic tactical plan for using intensive pasture management on their farm.

II. Key Points

1. Intensive pasture management is a prime alternative that dairy farmers can not afford to overlook. The potential economic gain is too great to ignore.
2. Pasture management takes a great deal of planning, controlling, and technical understanding.
3. To understand what might be involved on the participants' farms they need to do some basic planning to see how intensive pasture management would fix their farms.

Is There Gold In Those Pastures?

The economic environment in which the dairy farm managers of today are forced to operate is at best challenging. While production costs have increased over the past 10 years milk prices have dropped. For many farmers this loss of income represents a financial hardship that threatens their very existence. Unfortunately many of the factors that influence profitability such as milk support price, the cost of labor, and machinery are beyond the immediate control of the farm manager. As a result, many dairymen will need to focus attention on adopting farming practices that can reduce the cost of production through alternatives that require less financial input, labor or energy. (Although there may be a number of areas on an individual farm where a manager can cut costs to streamline operations, the majority of dairymen in business today concentrating cost reduction efforts in the area of feeds and/or feeding strategies. This likely to return the greatest financial reward. The majority of dairy managers may gain the greatest financial reward by achieving cost reductions in the area of feeding strategies and forage production.) This is because the cost of feed amounts to between 40 and 60% of the total costs to produce milk.

In recent years the use of intensively managed pasture has received a great deal of publicity by the popular press, and many success stories have been featured. This should come as no surprise. From the standpoint of feeding livestock, grass is the most abundant, the most easily grown, and the cheapest crop that can be produced in New York State. Although most dairymen rely heavily on forage crops in their feeding programs to help reduce costs, most, if not all of the forage component is provided in the most expensive mechanically harvested and cured form rather than obtained from pasture.

Although pasture is utilized on most farms in the state to some extent, it generally exists as a mismanaged, under utilized resource whose productivity is far below potential. It is, therefore, the purpose of this training module to increase the awareness of dairymen of the value of pasture in lowering the costs of production, and to teach basic pasture management techniques that are specific to optimizing production in a dairy situation.

Forage Production Idea Sheet
Is There Gold in Those Pastures

Ideas I like in this section	What I will do to follow up	Other information I need to follow up

ACTIVITY 12

Protecting the Forage Crop Investment in the Field

I. Learning Goals of this Activity:

1. To apply appropriate management techniques to optimizing the economic and environmental efficiency of pest control and crop production decisions.

2. To realize the importance of utilizing regularly collected field information to protecting the "Investment in the Field" and optimizing crop protection and crop production decisions.

3. To identify other opportunity areas for using timely field information.

4. To introduce the concepts and benefits of using an Integrated Pest Management (IPM) approach to crop management; this approach is an extension of other sound farm management techniques.

5. To learn where and how to acquire IPM materials.

II. Key Points:

1. Optimizing on farm production of forages can be accomplished when appropriate actions are taken that reflect management decisions based on timely information. Many major factors limiting yield or quality of forage production are predictable and can be efficiently managed in a systematic way.

2. Proper crop protection and crop production requires careful planning and follow through from preplanting decisions through the harvest and feeding process.

3. Optimizing yield and quality of forage production requires attention to crop and pest status which information should be regularly collected from field visits.

4. Management decisions regarding pests should be individualized field by field, crop by crop to best utilize financial resources, avoid unnecessary losses or expenses and minimize environmental impact. These management decisions can be made on the basis of an analysis of pertinent information and an assessment of the consequences of action and no-action.

5. This approach of information for improving management decisions is the heart of the Integrated Pest Management approach to pest control and to sound crop production management.

Pest Quiz

(matching)

Slide #	Pest
1. ____	a. Anthracnose
2. ____	b. Redroot pigweed
3. ____	c. Alfalfa weevil larva
4. ____	d. Verticillium wilt
5. ____	e. Quackgrass
6. ____	f. Lady bird beetle
7. ____	g. Common leaf spot
8. ____	h. Corn rootworm beetle
9. ____	i. Canada thistle
10. ____	j. Sclerotinia crown and stem rot
11. ____	k. Tarnished plant bug
	l. Common lambsquarter
	m. Phytophthora root rot
	n. Potato leafhopper

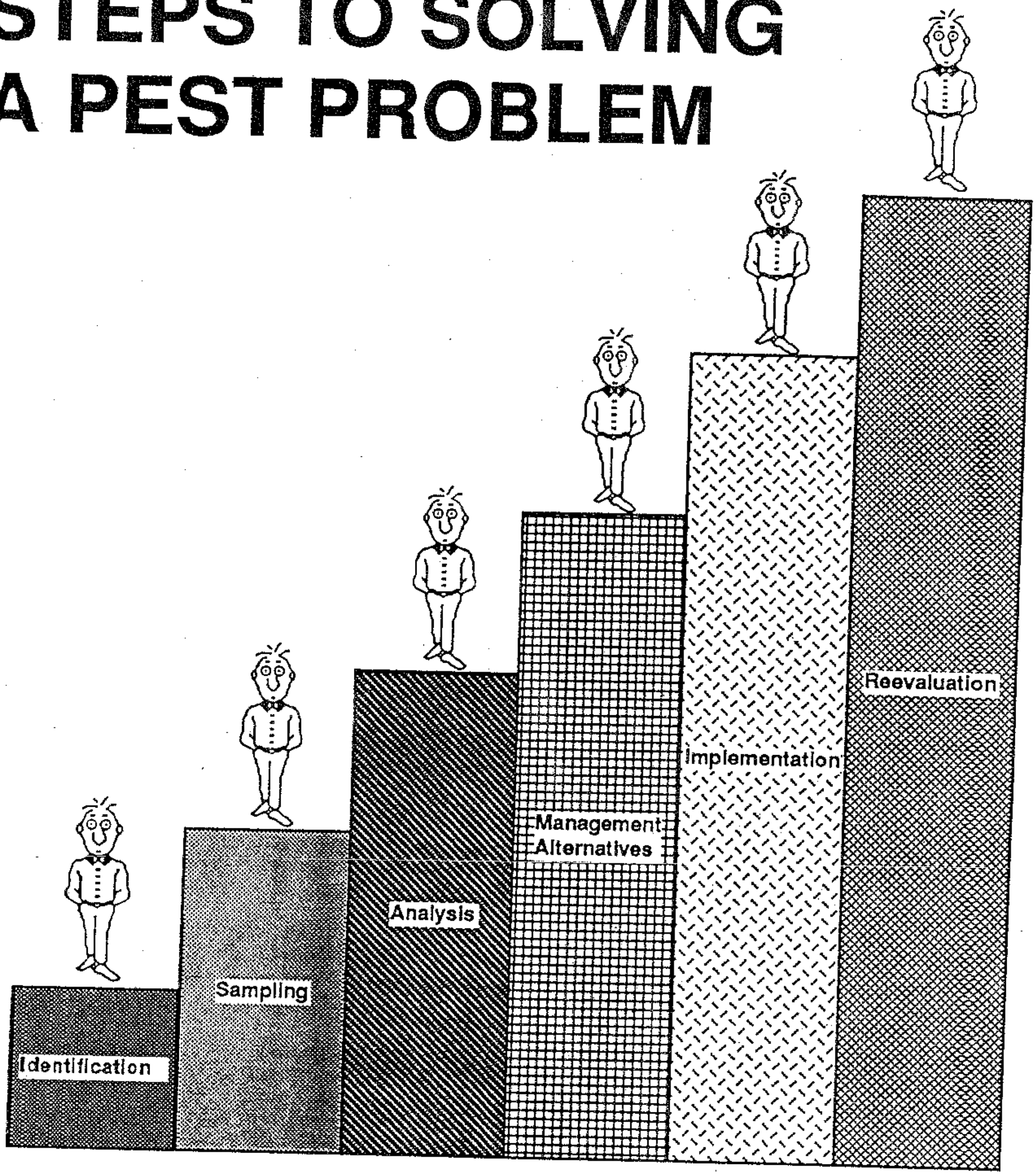
Bob Bovine - Case Study

Bob Bovine has operated a 300 acre, 65 milking cow operation in Productive Valley, NY for more than 15 years. For the past five years Bob has been keeping crop records on his alfalfa and field corn acreages. Lately he has noticed a decline in yield from his 2 year old "Back Thirty" alfalfa field. This field is on a hill side with a perched water table and several small seasonally active springs. Bob normally expects 3.75 T/A from his two year old alfalfa stands and was surprised when this field only gave him 2.5 T/A this year. It has been a hectic year for Bob. His time has been divided managing the day to day activities of the farm, as well as installing a new bunker silo, increasing his manure handling facilities, expanding his replacement heifer business, working the new rented ground, the new responsibilities with the volunteer fire department, and making use of Bob Jr. before he skips out for college next fall. With all these activities, Bob has only visited the "Back Thirty" a handful of times this year to check on crop progress. He has, however, written down his observations as follows:

<u>Field: Back Thirty - acres 30 - Alfalfa - "Super Green"</u>

DATE	COMMENTS
8/15/88	New Stand, second cut 1 T/A some quackgrass SE corner of field spring.
1/06/89	Little to no snow cover. Ice sheet in SE corner about 3 inches thick.
4/10/89	Year two. Thin stand near spring areas, quackgrass more evident in areas, winter kill wide spread throughout field.
6/09/89	First cutting less than .75 T/A, field with grayish color, 60% of leaves with skeletonized, shot holed appearance.
7/24/89	Notice many plants with yellowish V-shaped pattern at tips of leaves, some areas of the field 10% of plants appear dead.
8/30/89	Soil sample taken pH 5.7
9/10/89	Total crop yield for 2nd year 2.5 T/A

STEPS TO SOLVING A PEST PROBLEM



WHERE ARE YOU?

Potato Leafhopper (PLH)

I. Identification

1. Morphology and Life History
   - Appear Second and Later Cuttings.
   - Adults lime-green 1/8 inch long, very active.
   - Nymphs yellow-green in color, walk sideways when disturbed.
   - When present, generally well distributed throughout the field.
   - Do not over-winter in New York, must come with the winds.
   - Highly sporadic season to season.

2. Damage
   - Piercing-sucking mouth parts = protein loss from leaves
   - Characteristic V-shaped Yellow symptom on leaves
   - Damage may be confused with Verticillium Wilt or Boron Deficiency (Check for presence of insects!)

II. Sampling

1. Sweep Net
   - Absolutely necessary to determine leafhopper numbers.
   - Fields are commonly sampled in an M-shaped or X-shaped pattern. Fields of odd shapes require modifications of the above patterns.

2. Sample representative areas across the field taking 10 sweeps per area. The number of sampling sites taken within a field is dependent on the sampling method used. For this exercise use the sequential sampling method.

3. A sweep is one pendulum movement down and back through the alfalfa.

4. Alfalfa stems should be randomly measured at each sample site to estimate average crop height.

5. Total all PLH found and average to number PLH/sweep.

III. Analysis

1. A management decision is reached by comparing the number of leafhoppers per sweep to the height of the alfalfa.

2. Sampling Methods.
   - Standard Method:

Stem Height in Inches	Avg. No. Leafhoppers per Net Sweep
<3"	0.2
3-7"	0.5
8-10"	1.0
11-14"	> 2.0 Harvest within one week or treat with short residual insecticide
>14"	

   - Sequential Sampling Method: (E. J. Shields and D. R. Specker, Dept. of Entomology, Cornell University)

   - Sequential sampling methods combine sampling procedures with treatment thresholds to maximize sampling accuracy and minimize sampling efforts. In many situations, accurate potato leafhopper control/no control decisions can be made more rapidly using the sequential sampling procedure illustrated below than the previously described sampling methods.

     The sequential sampling plan is composed of four different PLH population treatment thresholds with selection of the appropriate population treatment levels based on the number of PLH observed at a particular crop height.

   - Take 10 sweeps at each of three different field sites in a transect diagonally across the field (Figure 1). Sum the total number of PLH (adults and nymphs) collected across the three sites. Measure the height of the alfalfa at each site to determine the appropriate PLH population treatment threshold.

   - Select the appropriate treatment threshold based on the height category which most closely matches the measured crop height (Table 1). Compare the total number of PLH collected with the decision columns adjacent to the 3 site column. If PLH numbers match the values in the "Don't Treat" or "Treat" column, you are finished sampling the field and should take the recommended action. When the management recommendation is "Treat" and the crop height is greater than 10 inches with normal harvest less than 10 days away, early harvest rather than the application of an insecticide should be considered. However, if observed PLH numbers match the values in the "Continue Sampling" column, take another sweep sample at an additional field site (Figure 4), add the number of PLH collected at the additional site to the total number of PLH collected in the field and refer to the table under the appropriate number of sites (4) for a decision. Repeat with additional sampling sites as necessary, until a decision is made or until you have sampled 10 sites. If after 10 field sites, a "Treat/No Treat" decision cannot be reached, the field should be re-sampled in 5-7 days.

IV. Management Alternatives

1. Harvesting is an excellent way to control the potato leafhopper.
   - If the alfalfa crop is within 10 days of harvest.
   - Clean harvest of the entire field is important.
   - Early regrowth must be closely monitored for surviving PLH.

2. Chemical control when harvesting is not possible.
   - Long residual chemicals when treatment is needed early in the cutting regrowth.
   - Short residual chemicals when late in the cutting schedule; Push the Pencil!
   - Compare available insecticides for applicator safety level, ease of application, days until harvest, and cost of the insecticide.
   - Currently registered insecticides for use on PLH in alfalfa are listed in the "Cornell Recommends for Field Crops".
   - For Chemicals available See Table 2 of this exercise.

V. Implementation

1. Harvest- thorough and clean.

2. Thorough coverage is essential.

3. Early regrowth must be closely monitored for surviving PLH.

VI. Reevaluation

1. Recheck fields for evaluation of chosen actions.
   - Damage? You can see it!
   - Spray efficacy?

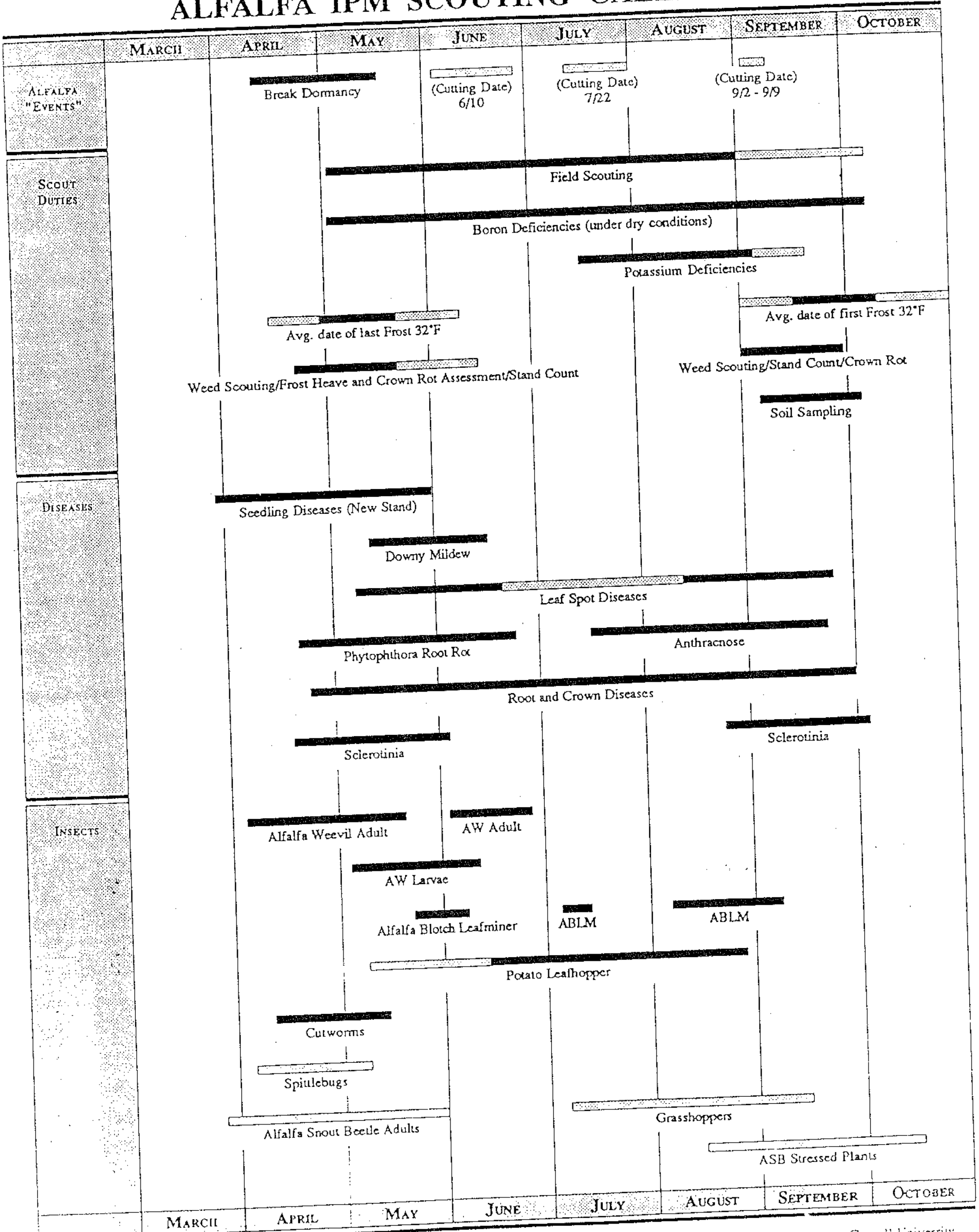
VII. Additional Information

Cornell Field Crops and Soils Handbook, Cornell Recommendations for Field Crops, Cornell Alfalfa IPM Scouting Protocols.

Table 1. Sequential table for sampling Potato Leafhopper on alfalfa in New York

Crop height (in.)	Sample (site) no.	Cumulative number of PLH		
		Don't treat	Continue sampling	Treat
< 3	3	≤ 2	3 - 8	≥ 9
	4	≤ 4	5 - 10	≥ 11
	5	≤ 5	6 - 12	≥ 13
	6	≤ 7	8 - 14	≥ 15
	7	≤ 9	10 - 15	≥ 16
	8	≤ 11	12 - 17	≥ 18
	9	≤ 13	14 - 19	≥ 20
	10	≤ 15	16 - 21	≥ 22
3-6	3	≤ 9	10 - 19	≥ 20
	4	≤ 14	15 - 24	≥ 25
	5	≤ 18	19 - 29	≥ 30
	6	≤ 23	24 - 34	≥ 35
	7	≤ 28	29 - 39	≥ 40
	8	≤ 33	34 - 44	≥ 45
	9	≤ 38	39 - 48	≥ 49
	10	≤ 43	44 - 53	≥ 54
7-10	3	≤ 19	20 - 40	≥ 41
	4	≤ 29	30 - 49	≥ 50
	5	≤ 39	40 - 59	≥ 60
	6	≤ 49	50 - 69	≥ 70
	7	≤ 59	60 - 79	≥ 80
	8	≤ 69	70 - 89	≥ 90
	9	≤ 79	80 - 99	≥ 100
	10	≤ 89	90 - 109	≥ 110
> 10	3	≤ 44	45 - 74	≥ 75
	4	≤ 64	65 - 94	≥ 95
	5	≤ 84	85 - 114	≥ 115
	6	≤ 104	105 - 134	≥ 135
	7	≤ 124	125 - 154	≥ 155
	8	≤ 144	145 - 74	≥ 175
	9	≤ 164	165 - 194	≥ 195
	10	≤ 184	185 - 214	≥ 215

ALFALFA IPM SCOUTING CALENDAR



Developed by: J. K. Waldron, G. E. Bergstrom, E. J. Shields, R. R. Hahn, R. R. Seaney

Cornell University
Dairy/Field Crops IPM
5/1989

Alfalfa IPM - Scouting Report

Grower:____________________ **Scout:**____________ **Date:**________________

Weather: Temp:________ partly sunny cloudy rainy calm light wind strong wind

IPM Field No.:_____ - 100 -____ -____ (office use)

Field Name: ________________________________ **Time:** in: out:

Plant Devel.: Ht. (inches) _____ Growth Stage: _____ %Bud: _____ %Bloom: _____

Soil Condition: wet moist dry loose light crust hard crust

Pest	Count	Unit	Threshold	Status	MAP

COMMENTS:______________________________

IPM Field No.:_____ - 100 -____ -____ (office use)

Field Name: ________________________________ **Time:** in: out:

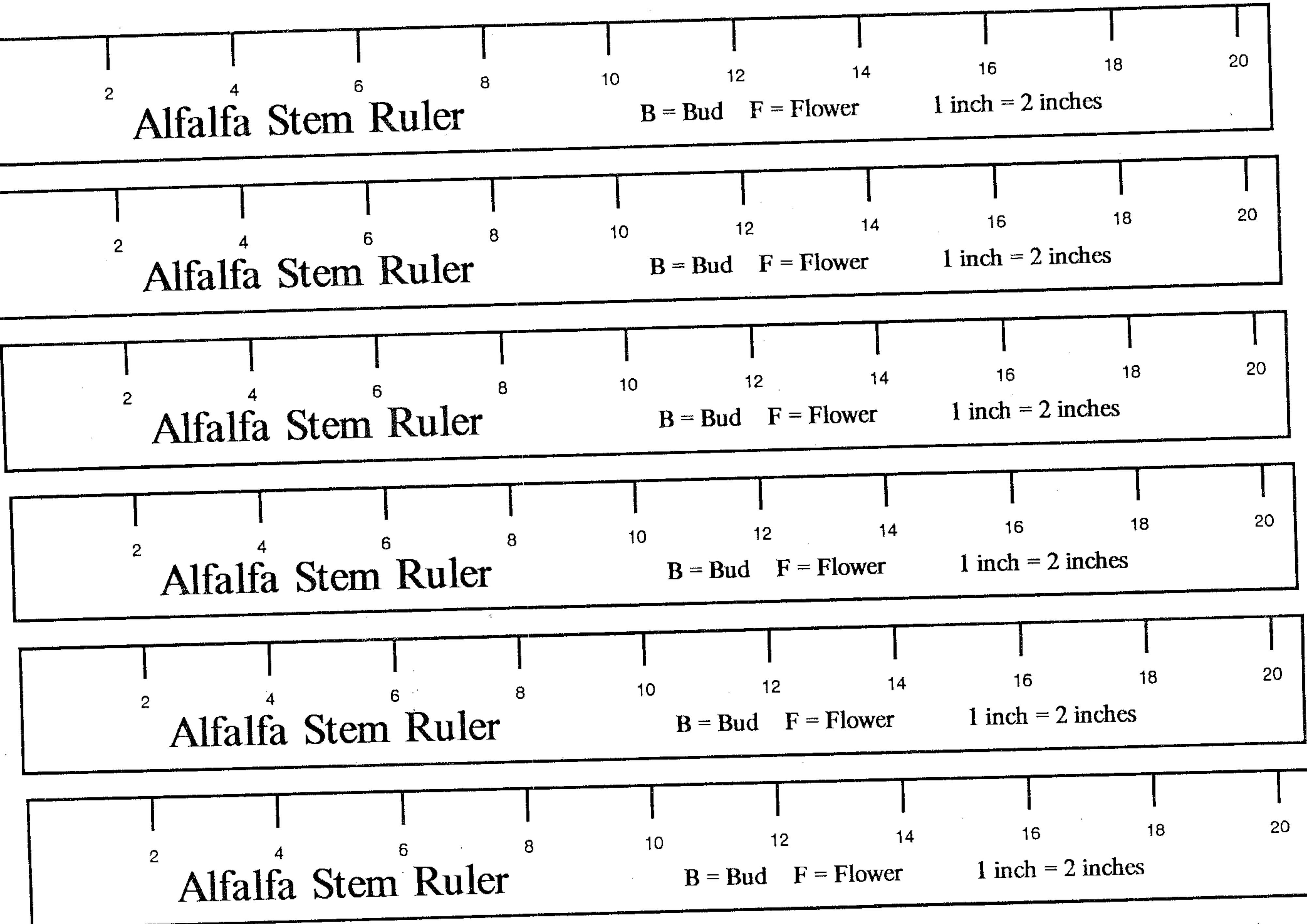
Plant Devel.: Ht. (inches) _____ Growth Stage: _____ %Bud: _____ %Bloom: _____

Soil Condition: wet moist dry loose light crust hard crust

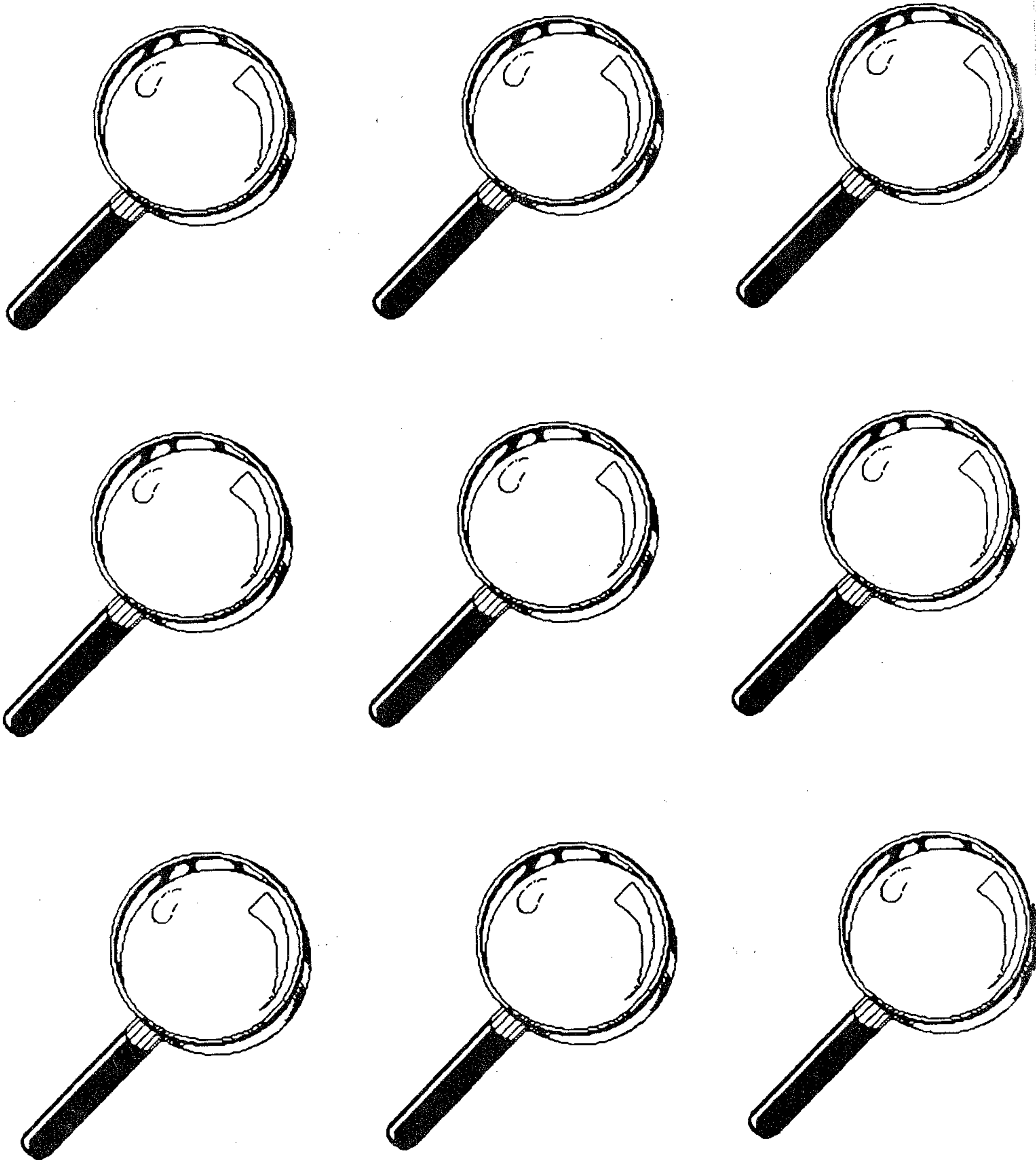
Pest	Count	Unit	Threshold	Status	MAP

COMMENTS:______________________________

Common Abbreviations: AW=Alfalfa Weevil, CRWN=crown, PLH=Potato Leafhopper; PLT=plant; PRR=Phytophthora Root Rot; SWP=Sweep; VERT=Verticillium Wilt



Use these rulers to measure the stems. Make estimates to the nearest mark and read directly from the ruler. You may use real rulers but 1 inch should be reported as 2 inches. Cut out rulers and laminate for protection.



Instructor, you will only need five of the magnifying glass to use as Potato Leafhopper Samplers. Cut out the five and use a paper punch to punch one hole in the center of each. Once accomplished laminate them for protection.

17	10	41	4	2	11	8	4	113	4	12	30	53	22	0	13	65	8	26	26	4	51	25	17	2	101
2	10	22	18	3	32	4	7	1	27	18	32	3	9	8	1	20	9	1	27	23	25	72	10	92	34
2	2	5	3	6	25	0	36	10	18	12	5	31	3	24	4	14	3	3	9	33	33	59	26	5	24
4	10	13	43	33	13	9	23	28	7	2	5	7	43	2	2	18	77	20	48	40	11	139	17	44	4
6	1	2	11	49	1	3	3	3	40	4	12	1	1	35	1	51	3	3	17	45	16	12	10	34	3
4	8	14	20	3	3	2	14	4	27	15	4	17	1	53	2	6	41	8	8	101	28	11	8	2	8
1	39	22	6	0	7	10	20	91	13	8	2	7	28	12	2	34	3	59	37	37	1	113	10	28	4
0	4	11	21	20	16	8	2	17	1	24	3	70	10	13	14	0	17	20	5	5	20	11	63	4	1
0	13	15	30	10	8	15	122	13	5	14	15	23	9	6	9	8	10	41	25	7	0	5	36	5	27
3	4	10	4	12	35	4	27	0	15	16	32	4	7	15	11	5	15	45	1	25	34	35	13	3	1
2	12	16	2	6	3	19	18	12	13	7	3	44	11	27	15	4	48	369	19	19	14	0	26	4	16
2	18	7	68	8	3	5	4	47	39	0	4	8	5	40	12	54	23	76	26	2	14	45	10	13	59
2	48	12	2	19	22	24	32	18	31	7	3	1	10	58	17	3	3	38	42	50	244	18	50	87	31
1	2	19	7	3	4	5	17	17	1	49	13	24	6	26	2	115	8	44	33	27	29	77	28	53	10
3	33	23	5	3	2	0	11	21	5	6	13	3	17	10	14	13	5	3	32	33	53	8	10	12	28
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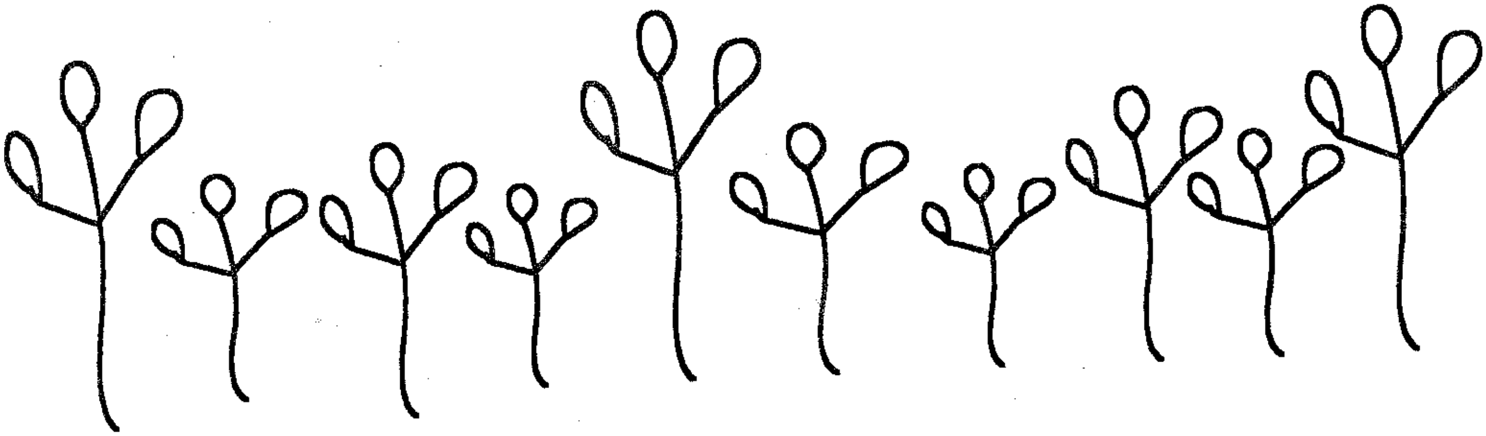

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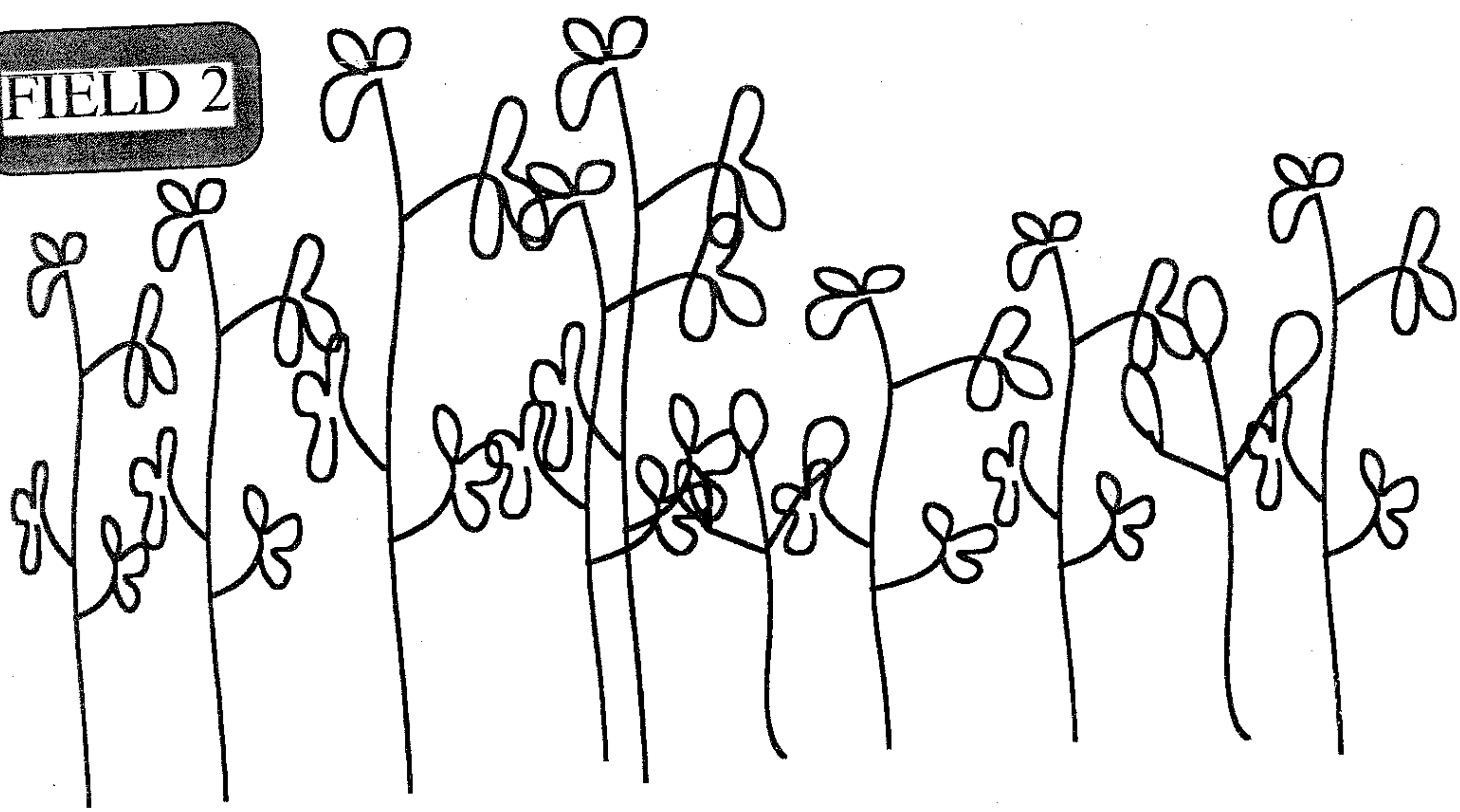

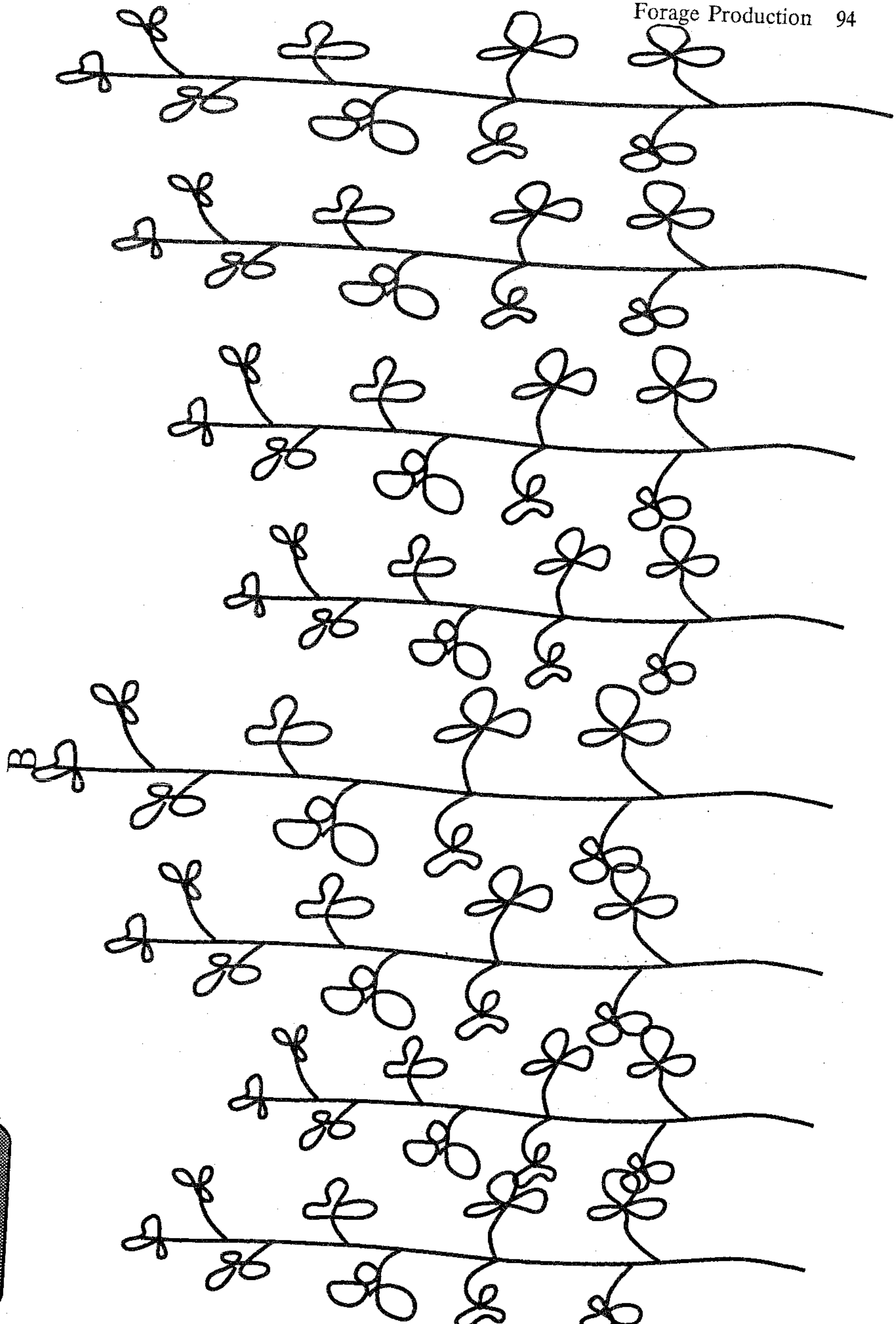
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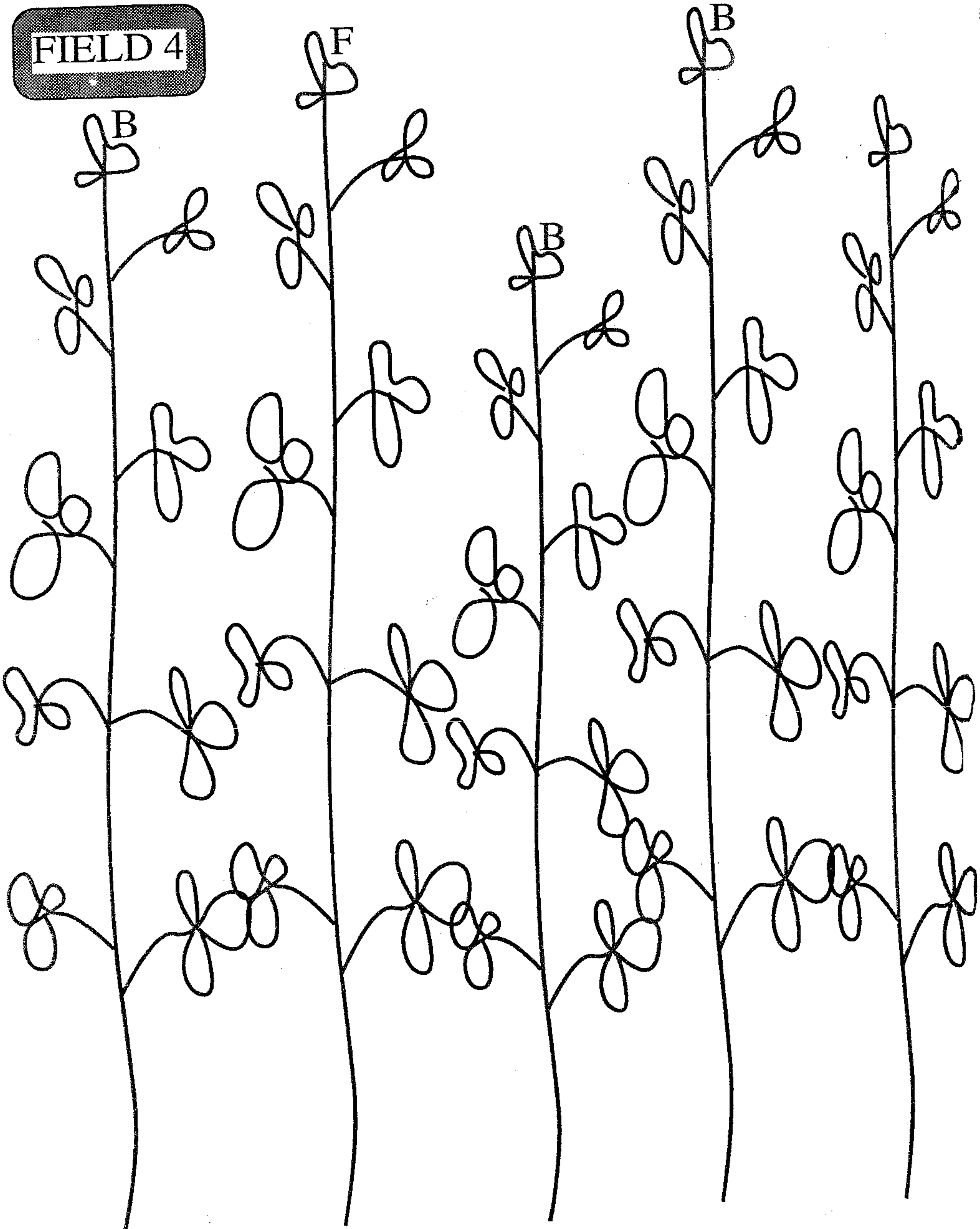
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Forage Production Idea Sheet
Protecting the Forage Crop Investment in the Field

Ideas I like in this section	What I will do to follow up	Other information I need to follow up

ACTIVITY 13

Putting the Forage Production Plan Together

I. Learning Goals of this Activity

1. To have the opportunity to assemble the ideas you have gathered during the course and develop tactical plans to pursue those ideas.

2. To have the opportunity to review the course, discuss individual issues, and find out what other resources or programs are available.

II. Key Points

1. An idea has no value if it isn't remembered, it has potential value if it is remembered, and real value if it is acted on. This section is at least an opportunity to catch some ideas before they are forgotten.

Forage Production Idea Sheet
Putting the Forage Production Plan Together

Ideas I like in this section	What I will do to follow up	Other information I need to follow up

Tactical Plan

Objective: ______________________

Goal: ______________________

	WHAT task or activity is to be done?	WHO will perform the task?	HOW should the task be done?	WHERE should the task be done	WHEN should the task be done?	Have the 5 functions of management been adequately addressed?
1						Planning Organizing Staffing Directing Controlling
2						Planning Organizing Staffing Directing Controlling
3						Planning Organizing Staffing Directing Controlling
4						Planning Organizing Staffing Directing Controlling
5						Planning Organizing Staffing Directing Controlling

Tactical Plan

Objective: ____________________
Goal: ____________________

	WHAT task or activity is to be done?	WHO will perform the task?	HOW should the task be done?	WHERE should the task be done	WHEN should the task be done?	Have the 5 functions of management been adequately addressed?
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Tactical Plan

Objective: ____________________

Goal: ____________________

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Tactical Plan

Objective: ______________________

Goal: ______________________

	WHAT task or activity is to be done?	WHO will perform the task?	HOW should the task be done?	WHERE should the task be done	WHEN should the task be done?	Have the 5 functions of management been adequately addressed?
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2						Planning Organizing Staffing Directing Controlling
3						Planning Organizing Staffing Directing Controlling
4						Planning Organizing Staffing Directing Controlling
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Tactical Plan

Objective: ______________________

Goal: ______________________

	WHAT task or activity is to be done?	WHO will perform the task?	HOW should the task be done?	WHERE should the task be done	WHEN should the task be done?	Have the 5 functions of management been adequately addressed?
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2						Planning Organizing Staffing Directing Controlling
3						Planning Organizing Staffing Directing Controlling
4						Planning Organizing Staffing Directing Controlling
5						Planning Organizing Staffing Directing Controlling

Approximate Dry Matter Capacity of Silos*

Depth of Settled Silage (feet)	Inside Diameter of Silo 10	12	14	16	18	20	22	24	26	28	30
2	0	1	1	1	2	2	2	2	3	3	4
4	1	2	2	3	4	5	5	6	8	9	10
6	2	2	3	4	5	7	8	10	11	13	15
8	3	4	5	7	9	11	13	16	18	21	24
10	4	5	7	9	11	14	17	20	24	28	32
12	5	7	9	11	14	18	22	26	30	35	40
14	5	8	11	14	17	22	26	31	36	42	48
16	6	9	12	17	21	26	32	37	44	51	58
18	7	11	14	19	24	29	35	42	49	57	65
20	8	12	16	21	27	33	40	47	56	65	74
22	9	14	19	24	30	38	48	54	64	74	85
24	11	15	21	27	34	43	52	61	72	83	96
26	12	17	23	30	38	48	58	68	81	94	107
28	13	19	26	35	44	53	64	76	90	104	119
30	15	21	29	38	47	59	71	84	99	115	132
32	16	23	32	41	52	65	78	93	109	127	145
34	18	25	34	45	57	70	85	101	119	137	158
36	19	28	37	48	62	76	92	109	129	150	172
38	21	30	41	53	67	82	100	118	139	161	185
40	22	32	44	57	72	89	107	127	150	173	199
42	24	34	47	61	77	95	115	137	161	186	214
44	26	37	50	65	82	102	123	146	172	200	229
46	27	39	53	69	88	108	131	155	183	212	244
48	29	42	56	74	93	115	140	166	195	226	260
50	31	44	60	78	99	122	148	175	206	239	274
52	32	47	64	83	105	129	157	186	219	254	291
54	34	49	67	88	111	137	165	197	231	267	306
56	36	51	71	93	117	144	174	207	243	282	324
58	38	54	74	98	123	151	183	218	261	297	339
60	40	56	78	102	129	159	192	228	273	309	357
62					135	167	201	239	287	324	374
64					142	174	210	250	301	339	391
66					149	182	219	260	314	354	407
68					155	190	228	271	328	369	424
70					162	198	237	282	342	384	441
72								293	356	400	458
74								305	371	415	476
76								316	385	431	493
78								328	400	446	511
80								339	415	462	528

To find the tons remaining in a silo after part of the silage is removed: (1) find the tons of silage when the silo was filled, (2) find the tons in a silo filled to the height equal to the depth of silage removed, (3) subtract the number of tons in Step (2) from the number of tons in Step (1). Example: A 20 foot silo filled to a settled depth of 60 feet and 22 feet were fed off. (1) 20 x 60 equals 159 tons (2) 20 x 22 equals 38 tons (3) 159 minus 38 equals 121 tons remaining.

* This table was adapted from a silo capacity table developed by the National Silo Association, 1201 Waukegan Road, Glenview, Illinois and added to by the Department of Agricultural Engineering and Agricultural Economics, the University of Wisconsin.

Dry Matter Tonnage For Corn and Hay Crop Silage In Well-Packed Horizontal Silos

Average Width (Ft)	Average Depth of Silage (Feet) 6	8	10	12	14	16	18	20
	Dry Matter (Tons/Foot of Length)							
12	0.4	0.5	0.7	0.9	1.1	1.3	1.5	1.7
16	0.5	0.7	1.0	1.2	1.4	1.7	2.0	2.3
20	0.7	0.9	1.2	1.5	1.8	2.1	2.5	2.9
24	0.8	1.1	1.4	1.8	2.2	2.6	3.0	3.5
30	1.0	1.4	1.8	2.2	2.7	3.2	3.8	4.4
40	1.3	1.8	2.4	3.0	3.6	4.3	5.0	5.8
50	1.7	2.3	3.0	3.7	4.5	5.4	6.3	7.3
60	2.0	2.7	3.6	4.5	5.4	6.4	7.5	8.7
70	2.3	3.2	4.2	5.2	6.3	7.5	8.8	10.2
80	2.6	3.7	4.8	5.9	7.2	8.6	10.0	11.6
90	3.0	4.1	5.4	6.7	8.1	9.6	11.3	13.1
100	3.3	4.6	6.0	7.4	9.0	10.7	12.5	14.5
Density°	11	11.44	11.9	12.38	12.88	13.40	13.94	14.5
% Vol. Loss°°	8.3	6.3	5.0	4.2	3.6	3.1	2.8	2.5

° Density increases with depth 4%/2 ft.
°° Percent volume loss with top surface spoilage 0.5 ft. deep

* Top spoilage can exceed 15% with poor procedures
and be less than 5% on very large horizontal silos or
with carefully placed and weighted plastic

* Average dry matter retention vs. buried bags on 11 farms
85% in 5 silos for hay crop silage
86% in 40 silos for corn silage (1978 chore red.)

* Summer feeding rates should use 1/2 ft. of exposed face daily
winter rates can be 1/4 foot

Corn Grain Conversion Work Sheet

	Percent Moisture	Tons as Harvested[1]		Conversion Factor[2]		Dry Shell Equivalent
Ear Corn:	____%	____T	÷	______	=	______ bushels
	____%	____T	÷	______	=	______
Shell Corn:	____%	____T	÷	______	=	______ bushels
	____%	____T	÷	______	=	______
				Total		______ bushels

[1]Use Table 1 below. [2]Use Table 2 below.

Tower Silo Capacities Moisture For High Moisture Corn

Settled Depth	Tons High Moisture Ear Corn[1] Inside Diameter in Feet 14	16	18	20	Tons High Moisture Shelled Corn[2] Sealed Storage 20 Feet Diameter
15	47	62	78	97	113
20	65	84	107	132	154
25	83	108	137	169	192
30	102	133	168	207	235
35	121	158	200	247	274
40	142	185	234	289	320
45	163	213	269	332	360
50	185	241	305	377	407
55		271	342	423	448
60		302	381	471	498
65			421	520	
70			462	571	

[1]Based on 33 percent moisture content. [2]Based on 28 percent moisture content.
HMEC stored in horizontal silos will range from 40 to 42 pounds per cubic foot.

Corn Conversion Table

Percent Moisture in Kernel	Tons of Shelled Corn Needed to Equal One Bushel of Dry Shelled[1]	Percent Moisture in Whole Ear	Tons of Ear Corn Needed to Equal One Bushel of Dry Shelled Corn[1]
14.0	0.0275	14.2	0.0335
15.5	0.0280	16.0	0.0342
16.0	0.0282	16.6	0.0345
18.0	0.0289	19.7	0.0357
20.0	0.0296	22.6	0.0370
22.0	0.0300	25.2	0.0384
24.0	0.0312	27.9	0.0399
26.0	0.0320	30.0	0.0414
28.0	0.0329	32.6	0.0428
30.0	0.0338	34.6	0.0443
32.0	0.0348	36.4	0.0457
35.0	0.0364	39.3	0.0479

[1]One bushel of no. 2 corn at 15.5 percent moisture content.

Estimating Yields

To estimate your haylage and corn silage yields more accurately than just the number of wagon loads per acre, here is a chart that was computed by Cornell Cooperative Extension that estimates the amount of silage that wagons typically hold.

Wagon Load Chart (Dry Matter)

	Hay Tons	Corn Silage
Small 14′ Wagon Load	1.5	1.8
Large 14′ Wagon Load	1.8	2.1
Small 16′ Wagon Load	1.7	2.0
Large 16′ Wagon Load	2.1	2.4

Conversions

Tons of D.M.	35% D.M. Silage	45% D.M. Silage
1.5	4.7	3.3
1.7	5.3	3.8
1.8	5.6	4.0
2.0	6.2	4.4
2.1	6.6	4.7
2.4	7.5	5.3

SOILS

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Managing Animal Manure as a Resource Part II: Field Management

by Stuart Klausner and
David Bouldin
Department of Agronomy
Cornell University

On most livestock farms, manure is a major source of plant nutrients. The nutrients in manure can be used very effectively in crop production, and their proper management can materially reduce fertilizer costs.

This publication will discuss the management practices necessary to increase economic benefits from manure. It will also provide examples and work sheets to calculate (1) the quantity of nutrients produced on the farm, (2) an estimate of nitrogen availability, and (3) a rate of application to meet a specified nutrient requirement. This is the second fact sheet of a two-part series. The first one, entitled *Managing Animal Manure as a Resource. Part I: Basic Principles*, should be read first because it covers the basic concepts concerning the nutrient content of manures, the forms and behavior of nitrogen and its effect on crop yield, and the use of manure as a source of plant nutrients.

Nutrient Management

The first priority of a land application program is to incorporate manure into an overall soil fertility program. As a first step, the quantity of nutrients produced should be compared with the total nutrient requirement of your crop rotation. Using this information, a management program can be developed to ensure that manure will supply a major portion of the nutrient requirement.

If the crops require more nutrients than the manure contains you should consider changing management practices to conserve more of the nutrients. On the other hand, if there are more nutrients in the manure than are needed, there is no advantage in changing management to conserve more unless you can sell the excess, or the convenience or environmental concerns outweigh the economic returns, or it enables you to manage other areas more effectively.

Nutrient Production

Work sheet no. 1 will help you approximate the total weight of manure and the pounds of nitrogen, phosphorus, and potassium that are produced each year on your farm. It is worthwhile to have the manure analyzed periodically and to use the results in work sheet no. 1. If an analysis is not available, table 1 can be used to approximate the nutrient content. However, relying too heavily on average values may do more harm than good. Table 1 also provides a rough estimate of the quantity of manure produced each year. The amount collected in a storage can also be determined. Multiply the number of cubic feet of manure in a storage system by 62 (use 55 for very dry manure) and divide by 2,000 to estimate tons. For a liquid storage, multiply cubic feet by 7.5 to obtain gallons.

The example given in this work sheet shows that for an average New York dairy farm about 1,800 tons of manure are produced each year, containing approximately 18,000 pounds of nitrogen, 9,000 pounds of phosphate, and 16,000 pounds of potash.

Nutrient Availability

The nutrients in manure cannot be substituted for the nutrients in commercial fertilizer on a pound-for-pound basis. A portion of the nutrients in manure is not as readily available nor can these nutrients be as efficiently applied as those in fertilizer. Therefore, the amount of fertilizer nitrogen that manure can replace has to be calculated, while the phosphorus and potassium contribution can be measured by soil testing on a regular basis.

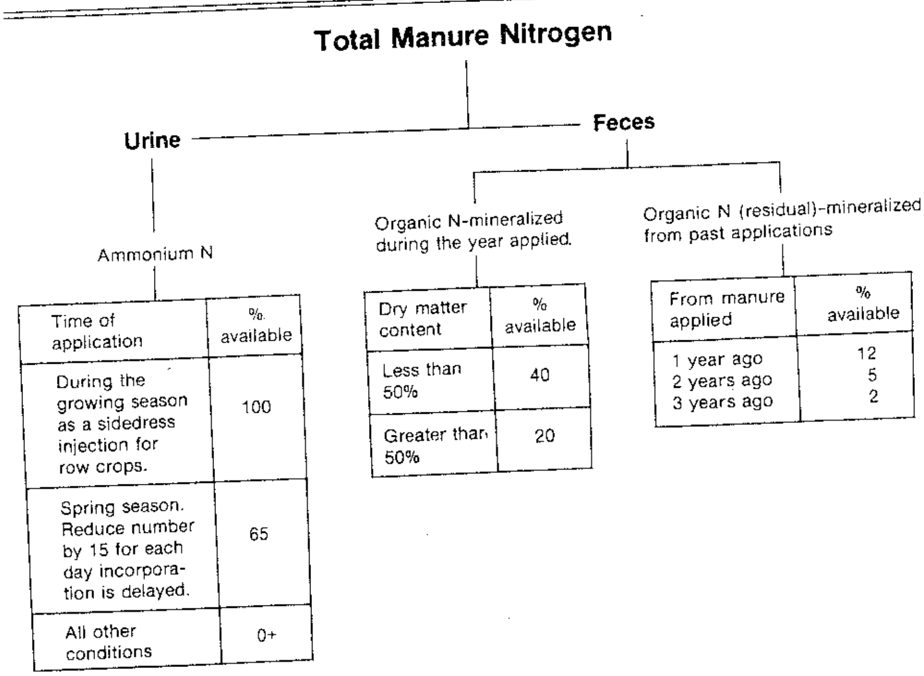


Figure 1. Estimated availability of the different forms of nitrogen in manure

Nitrogen. Typically, about 50% of the nitrogen (N) in fresh manure is in the ammonium form. The remaining nitrogen is present in an organic form. At every step between production and its utilization by the crop, ammonia is the most valuable and most easily lost component. It is also the most variable component between management systems and, therefore, an analysis of the manure is useful to determine how much ammonia has been conserved.

The calculations that follow assume that the ammonium content was determined from a representative sampling when the manure spreader was being loaded. This procedure accounts for ammonia losses prior to land application. Because the sample cannot be analyzed quickly enough, it is advisable to use this analysis for the next cleanout period. The previous analysis can be used for this time period. For a given feeding and handling system, the ammonium content should not change drastically.

The values in figure 1 can be used to approximate the availability of the different forms of nitrogen. Transfer these values to work sheet no. 2 to estimate availability based on your management practice. To determine the amount of nitrogen that is available from residual organic N, you need to have a previous manure analysis. If unavailable, the current analysis will be a reasonable approximation of what has been applied in the past. If previous rates of application cannot be obtained, skip this calculation. Save your records for the future.

The example in this work sheet points out that the amount of available nitrogen will be low when manure is spread during the fall of the year. The nitrogen value increases considerably by applying and immediately incorporating manure in the spring.

If you don't have a manure analysis, skip work sheet no. 2.

Phosphorus and Potassium. When manure has been applied over a long period of time, phosphorus and potassium can accumulate in the soil. Soil sampling should be done on a regular basis because the soil-test level is a reflection of how much phosphorus and potassium have been applied from past manuring. The soil-test value should then be used to determine the amount of fertilizer needed.

When establishing a crop, phosphorus is used more efficiently if it is banded close to the seed with the planter. Broadcasted manure is not an efficient method of applying phosphorus and, therefore, should not be used to satisfy the entire fertilizer phosphorus (P_2O_5) requirement for crop establishment. When the commercial fertilizer recommendation is less than 40 pounds of P_2O_5 per acre, use a row-placed fertilizer to satisfy the entire requirement. If the recommendations exceed 40 pounds, apply 40 pounds of fertilizer in the row and then use an appropriate rate of manure to make up the difference.

For topdressing hayfields, the phosphorus in broadcasted manure is probably as efficiently used as the phosphorus in broadcasted fertilizer.

Potassium can be used efficiently by plants as either a broadcast or banded application. The fertilizer potassium (K_2O) requirement generally can be met with the appropriate amount of manure.

If manure was applied after the soil test was taken, continue to follow Cornell's P_2O_5 and K_2O fertilizer recommendations. There won't be much change because of a single application. Any change will be reflected in next year's soil-test analysis and will result in an adjustment in the fertilizer recommendation.

Regardless of how much manure is applied, it is usually advisable to use a row-placed starter fertilizer containing N, P_2O_5, and K_2O when establishing a nonlegume crop. The nitrogen can be eliminated when establishing a legume.

Table 1. Approximate quantity of manure produced and most probable average (and range) of dry matter and nutrient composition of manure at the time of land application

Handling system		*Manure production per animal unit (1000 lb live wt)*	*Dry matter*	*Total N*	*Available N ** A	*Available N ** B	P_2O_5	K_2O
		tons/yr	*(%)*	lb/ton				
Nonliquid	Dairy	15	15 (12-20)	10 (8-12)	6 (5-8)	4 (3-5)	5 (4-6)	8 (7-10)
	Swine	15	12 (12-18)	12 (10-18)	7 (6-10)	5 (3-6)	9 (8-13)	8 (7-12)
	Poultry	10	50 (35-55)	35 (22-40)	17 (12-18)	9 (6-12)	55 (38-60)	22 (15-25)
		gal/yr†		lb/1000 gal				
Liquid	Dairy	5600	10 (8-12)	27 (22-34)	16 (12-20)	10 (7-12)	13 (10-15)	24 (20-30)
	Swine	8200	4 (3-6)	35 (25-50)	22 (16-34)	14 (10-20)	25 (18-30)	20 (15-30)
	Poultry	7600	8 (5-10)	40 (25-50)	27 (16-34)	19 (12-24)	35 (22-48)	15 (10-20)

NOTE: Use these averages if a more accurate estimate is not available. The majority of samples fall within the range given.

* Use column A for spring and early summer applications that are incorporated within 1 day. Use column B for all other conditions.

† Includes dilution water

Table 2. Approximate manure spreader capacities

I. Nonliquid System

a. Spreader volume

measure all dimensions in feet and tenths of feet

1. box spreader: cubic feet = length × width × average depth
2. barrel spreader: cubic feet = 0.393 × d^2(diameter squared) × length
3. irregular shapes: partition the various shapes into rectangles as best as possible and calculate the volume of each as: cubic feet = length × width × depth. Add the volumes together for the total.

b. Spreader capacity

$$\text{tons per load} = \frac{\text{cubic feet} \times 62 \text{ lb per ft}^3}{2000 \text{ lb per ton}}$$ (use 55 lb per ft^3 for extremely dry manure)

II. Liquid System

a. Tank spreader: use manufacturer's data to determine gallon capacity. Estimate the percentage of a full load. There are approximately 8300 lb in 1000 gal

Thousands of gal per load = gal ÷ 1000

Rate of Application

The rate of application should match the nutrient requirements of the crop as closely as possible. In a practical sense, complete utilization is impossible because the ratio of N to P_2O_5 to K_2O in the manure will not match the ratio needed by the crop. On some farms, there are more nutrients than are needed and they will accumulate in the soil. Further accumulation will occur from overapplying fertilizer. On the other hand, when the nutrient needs cannot be met with manure, fertilizer should be used to make up the deficit.

It takes some planning and pencil-pushing to devise an application rate that fits a particular cropping sequence. Work sheet no. 3 is offered to determine this rate. The work sheet is divided into several sections, which deal with tabulating the nutrient requirement of the crop, the nutrient content of the manure, the rate needed to supply the nutrient having the highest priority, and the quantity of commercial fertilizer needed in addition to the manure.

The nitrogen requirement of the crop can be determined by using the appropriate tables in the current issue of *Cornell Recommends for Field Crops*. Use the nitrogen recommendations listed for conditions where manure was not applied, because you need to know how much nitrogen must be added by a combination of manure and fertilizer. The fertilizer P_2O_5 and K_2O requirements can be obtained from a current Cornell soil test or from the fertilizer recommendation tables in *Cornell Recommends for Field Crops*.

As an added step in work sheet no. 3, the number of spreader loads needed to apply a given rate can be calculated. Refer to table 2 for the equations to determine spreader capacity. The manufacturer's data are not always useful if given as a heaped or struck-level capacity. This is hard to maintain because of road spillage.

After the rate for each field is tabulated, add the total amount of manure needed and compare this with the amount produced. If there is excess, and the manure cannot be sold, divide the excess by the number of acres receiving manure and increase the rate accordingly.

General Considerations

When making a capital investment for the purpose of conserving more nutrients, make a careful economic analysis of the change in your management. Nutrient surpluses are not economical unless sold, but an expenditure to markedly improve either environmental quality or your management ability is a good investment.

A series of management guidelines is offered to obtain the maximum benefit from manure.

1. Sound soil conservation practices are an important part of land management. Surface runoff and erosion should be controlled to conserve soil and plant nutrients.
2. It is best to apply manure just before spring planting and to incorporate it as soon as possible to reduce ammonia losses and odors.
3. Conserve the liquid during handling. It has a high plant nutrient content.
4. Fields that require high rates of nitrogen and that are low in phosphorus and potassium should get first priority.

Work Sheet No. 1. Estimating the quantity of manure, nitrogen, phosphate, and potash produced each year

Example: *A dairy farm has 75 cows and 50 heifers. The average weight of cows is 1300 lb and heifers average 500 lb. Manure is handled as a nonliquid. Calculate the amount of manure and quantity of N, P_2O_5, and K_2O produced annually.*

Calculations		Example	Your Farm
1. Determine the number of 1000 lb animal units.			
a. Total weight = no. of animals × weight per animal (75 cows x 1300 lbs) + (50 heifers x 500 lbs)	=	122,500 lbs	______
b. Animal units = total weight ÷ 1000 lb per unit 122,500 ÷ 1000	=	122.5 units	______
2. Determine the quantity of manure produced or collected annually. Quantity = tons or gal per animal unit from table 1 × number of animal units or 15 tons x 122.5 units Quantity = amount in storage × 12 ÷ months of storage	=	1837 tons	______
3. Determine the nutrient value of the manure. Insert the nutrient value of manure from a recent analysis or from table 1. *Express as lb per ton for a nonliquid system or as lb per 1000 gal for a liquid system.*	N =	10 lbs/ton	______
	P_2O_5 =	5 lbs/ton	______
	K_2O =	9 lbs/ton	______
4. Determine the quantity of N, P_2O_5, and K_2O produced or collected annually. Liquid system: lb per yr = gal per yr from item 2 ÷ 1000 × lb per 1000 gal from item 3.	N =	18370 lbs/yr	______
	P_2O_5 =	9185 lbs/yr	______
	K_2O =	16533 lbs/yr	______
Nonliquid system: lb per yr = tons per yr from item 2 × lb per ton from item 3. 1837 x 10 1837 x 5 1837 x 9			

5. Similar to fertilizer, manure must be spread as uniformly as possible to avoid erratic results.

6. Reduce the amount of commercial fertilizer added to compensate for the nutrient value of the manure.

7. Avoid spreading manure on hayfields with more than 50% legume. The extra nitrogen can encourage the grasses and weeds at the expense of the legume. Hay stands containing more than 50% grass will respond favorably to the added nitrogen.

8. Avoid overapplication. Nutrient additions in excess of crop needs have no economic value and may enrich our water resources unnecessarily.

When applications must be made in the fall or winter months, we offer the following suggestions.

1. Apply to fields with the least slope and to areas that are not subject to spring flooding.

2. Major problems with late fall and winter spreading are frozen soil or deep snow that makes fields inaccessible. Rutting of wet soils provides runoff channels until spring. Accumulated manure from storages should be spread before the beginning of continuous snow cover. If a snow pack or an ice sheet develops later, it will be over, rather than under, the manure. This practice provides some protection from runoff.

3. For daily spreading, the distance to and the accessibility of fields should be considered. Areas of limited access should be used early in the winter. Easily accessible lands can be used during periods of deep snow cover. This practice helps avoid overloading fields close to the barn.

Nutrient Monitoring

Use Cornell University's soil testing service and follow the recommendations to ensure a proper balance of plant nutrients. Keep a record of nutrient levels in a field and use this information as the basis for adjusting your manure management and soil fertility program.

Work Sheet No. 2. Estimating the amount of nitrogen available for crop production

Example: *A dairy manure sample was taken from a nonliquid storage facility and analyzed. The following calculations show how to estimate the amount of nitrogen that will be available during the growing season from the current manure application and from previous applications. Assume that 25 tons/acre were applied in each of the past 3 years, having an organic N content of 6 lb/ton.*

Calculations

1. Insert the percentage of dry matter and the nitrogen value of the manure from the analysis in lb per ton for a nonliquid system or lb per 1000 gal for a liquid system. *Organic N = Total N - Ammonium N*

	Example	*Your Farm*
Dry matter	15%	
*Total N**	10 lbs/ton	
Ammonium N	4 lbs/ton	
*Organic N**	6 lbs/ton	

2. Determine the availability of nitrogen during the first year. *Available N = lb of ammonium N or organic N in item 1 × the percentage of availability from figure 1.*

	Time of application	Ammonium N (lb × %)		Organic N (lb × %)		Available N
		- - - - - Quantity available from: - - - - -				
Examples:	Fall	4 x 0	+	6 x .40	=	2.4 lbs/ton
	Spring. Incorp. delayed 2 days	4 x .35	+	6 x .40	=	3.8 lbs/ton
	Spring. Immed. incorporation	4 x .65	+	6 x .40	=	5.0 lbs/ton
Your Farm:			+		=	

3. Determine the availability of nitrogen from previous applications. Omit those years when manure was not applied. *Available N per acre = application rate from previous records in tons or 1000's of gal × lb of organic N per ton or per 1000 gal × percentage of availability from figure 1.*

	1 year ago (rate × N × %)		2 years ago (rate × N × %)		3 years ago (rate × N × %)		Residual N availability
	- - - - - Quantity available from residual organic N from: - - - - -						
Example:	25 x 6 x .12	+	25 x 6 x .05	+	25 x 6 x .02	=	28.5 lbs/ac
Your Farm:		+		+		=	

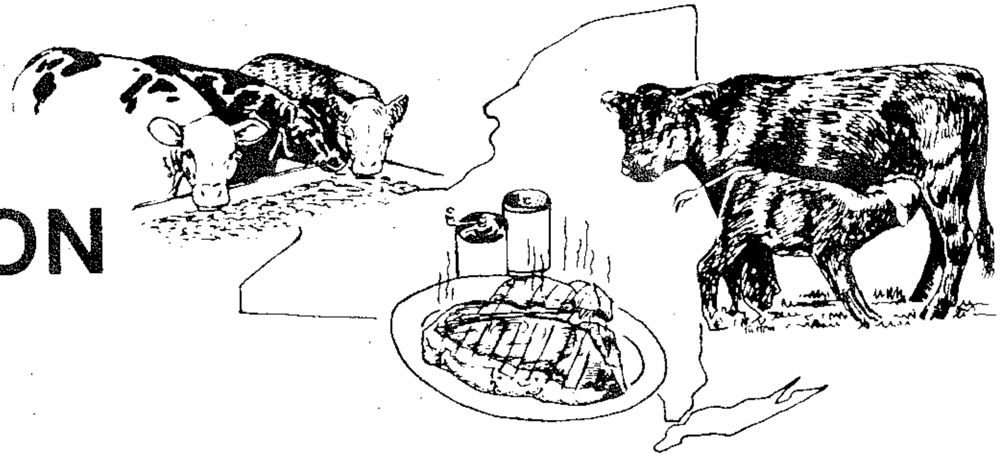
* Some laboratories may report their nitrogen results under the heading "nitrogen" and "ammonium or ammonia N." The larger of the two numbers is total N. Many laboratories do not report organic N simply because it is the difference between total N and ammonium N.

Work Sheet No. 3. Estimating a rate of application

Example: *A dairy farmer wants to apply a nonliquid, lightly bedded manure to a 15-acre cornfield. It will be applied in the early spring and incorporation will be delayed for one week. Manure had been applied often in the past. Determine (1) the rate of application to meet the nitrogen requirement, (2) the amount of P_2O_5 and K_2O applied in order to meet the N requirement, (3) the amount of commercial fertilizer needed, and (4) the number of spreader loads needed to apply the desired application rate.*

Calculations		*Example*	*Your Farm*
1. Determine the nutrient needs of the crop.			
a. Crop to be grown		Corn	______
b. Insert the quantity of N, P_2O_5 and K_2O needed. *Express as lb per acre.*	N =	120 lbs/ac	______
	P_2O_5 =	20 lbs/ac	______
	K_2O =	40 lbs/ac	______
2. Determine the nutrient value of the manure.			
a. Insert the nutrient content of manure. *Express as lb per ton for a nonliquid system or as lb per 1000 gal for a liquid system.*			
1. available N from work sheet no. 2 or table 1	N =	2.4 lbs/ton	______
2. from recent analysis or table 1	P_2O_5 =	5 lbs/ton	______
3. from recent analysis or table 1	K_2O =	9 lbs/ton	______
3. Determine the rate of application.			
a. Nutrient having the highest priority.	=	N	______
1. amount of this nutrient to be supplied by manure. *Express as lb needed in item 1b minus amount applied at planting.* 120 - 30 lbs at planting	=	90 lbs/ac	______
2. If nitrogen, subtract residual N availability from work sheet 2 — 90 lbs - 29 lb residual	=	61 lbs	______
b. Rate of manure needed to supply the nutrient having the highest priority (item 3a ÷ item 2a). *Express in tons per acre for a nonliquid system or as 1000's of gal per acre for a liquid system.* 61 ÷ 2.4 lbs/ton	=	25 tons/ac	______
c. Pounds of N, P_2O_5 and K_2O applied per acre with manure.			
1. N value from 2a.1 × manure rate from 3b + residual N availability from work sheet 2. 2.4 x 25 + 29	N =	89 lbs	______
2. P_2O_5 value from 2a.2 × manure rate from 3b — 5 x 25	P_2O_5 =	125 lbs	______
3. K_2O value from 2a.3 × manure rate from 3b — 9 x 25	K_2O =	225 lbs	______
4. Determine the amount of commercial fertilizer needed from the Cornell Soil Testing Report		*Fertilizer recommendation*	
a. available N from manure = 89 lbs	N =	30 lbs/ac	______
b. soil test P value = 9 (high)	P_2O_5 =	20 lbs/ac	______
c. soil test K value = 110 (medium)	K_2O =	40 lbs/ac	______
5. Determine the number of manure spreader loads required to apply the application rate in 3b.			
a. Spreader capacity *(use equations from table 2).*			
1. liquid system: *(Express in units of 1000's of gal per load.)*	=	______	______
2. nonliquid system: cu ft of spreader = 13.9' x 4.5' x 2.4'	=	150 ft^3	______
tons per load = 150 ft^3 x 62 lbs/ft^3 ÷ 2000	=	4.6 tons/load	______
b. Number of loads needed.			
1. loads per acre = manure rate in 3b ÷ spreader capacity from 5a — 25 ÷ 4.6	=	5.4 loads/ac	______
2. loads per field = loads per acre × acres — 5.4 x 15	=	81 loads	______

CORNELL BEEF PRODUCTION REFERENCE MANUAL



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Using Short Duration Grazing to Improve Pasture Production

Introduction

Short duration grazing (SDG) is the most advanced form of what is commonly referred to as rotational grazing. Unlike other grazing systems, SDG combines the principles of ecology, agronomy, plant physiology, and animal nutrition in a management system that promotes high forage yields, enhanced forage quality, increased harvest efficiency, and thus maximizes animal production per acre.

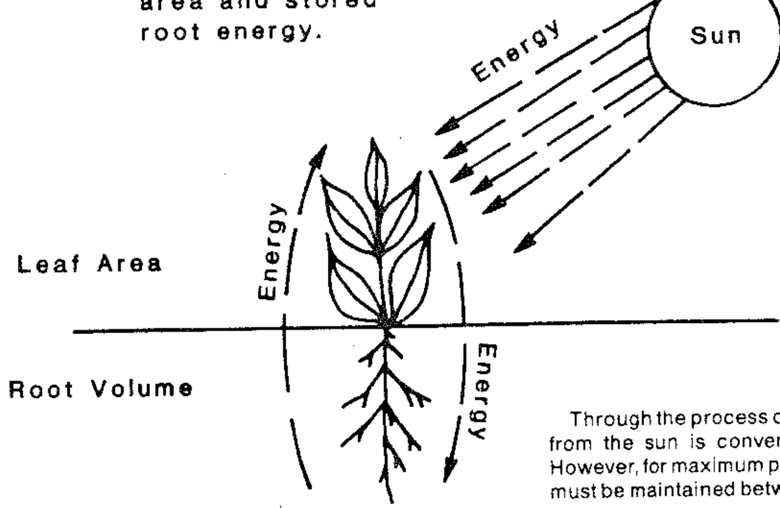
SDG involves subdividing pastures into grazing units called paddocks. The size and number of paddocks depend on the level of pasture productivity, stocking rate of livestock, and the desired speed of rotation. Individual paddocks are grazed one at a time in a planned order with livestock occupying each grazing unit for a period long enough to harvest the available forage, but not so long as to allow grazing of the regrowth of plants previously grazed. Generally, livestock are moved to new paddocks at least once per week. The most intensive systems may move livestock to new paddocks fourteen (14) times per week. After each paddock is grazed to the appropriate stubble height for the plant species present, the livestock are moved to a new paddock. Plants in paddocks previously grazed are then allowed to regrow and regain vigor before being grazed again.

Understanding How Plants Grow

The first step in understanding how SDG increases pasture productivity is to examine how pasture plants grow and respond to grazing.

A forage plant is a living system comprising two connected and dependent parts. There is an above-ground portion consisting of stems and leaves, and a below-ground portion composed of roots and root hairs. The roots and root hairs extract moisture and nutrients from the soil while the green leaves and stems convert light energy from the sun into energy for growth through the process of photosynthesis. (See figure 1.)

Figure 1. Relationship between leaf area and stored root energy.



Through the process of photosynthesis light energy from the sun is converted into energy for growth. However, for maximum productivity an energy balance must be maintained between leaf area and stored root energy.

Darrell L. Emmick, Grassland Specialist, Soil Conservation Service

Surplus energy generated by this process is stored by the plants as carbohydrates or sugars in the roots and stem bases. This stored energy is available for use by the plant to initiate growth in the spring or after defoliation, and to provide nourishment for survival over winter or during other periods of environmental stress. Enhanced levels of growth and production can only occur when an adequate energy balance is maintained between the above-ground and below-ground portions of the plant.

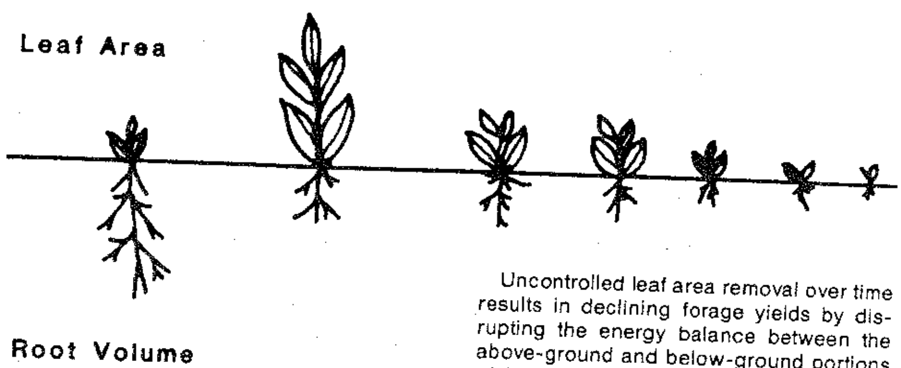
Effects of Improper Use

Although not generally appreciated by livestock producers, the grazing animal exerts an extremely negative impact on plant productivity. Through the forces of defoliation, trampling, and fouling with manure and urine, the grazing animal can influence what plant species can or cannot survive in a given pasture. In some cases the combined impacts of severe defoliation, trampling, and fouling of a pasture have been shown to reduce forage yields by as much as 60% as compared to the hay yield on the same field. Of the three negative impacts previously mentioned, uncontrolled defoliation is the most detrimental to pasture productivity as depicted in figure 2.

Frequent and/or severe removal of leaf area disrupts the normal growth and energy storage pattern and if continued over time reduces plant vigor, yield, and persistance.

Frequent leaf area removal not only reduces the above-ground forage yield, but also causes a decline in root volume. The loss of root volume reduces the plant's ability to extract moisture and nutrients from the soil and thus decreases the plant's capacity for regrowth. As a result, even though adequate soil moisture and fertility levels may be available for rapid plant growth, the plants are unable to respond.

Figure 2. Forage response under uncontrolled harvest conditions or continuous grazing management.

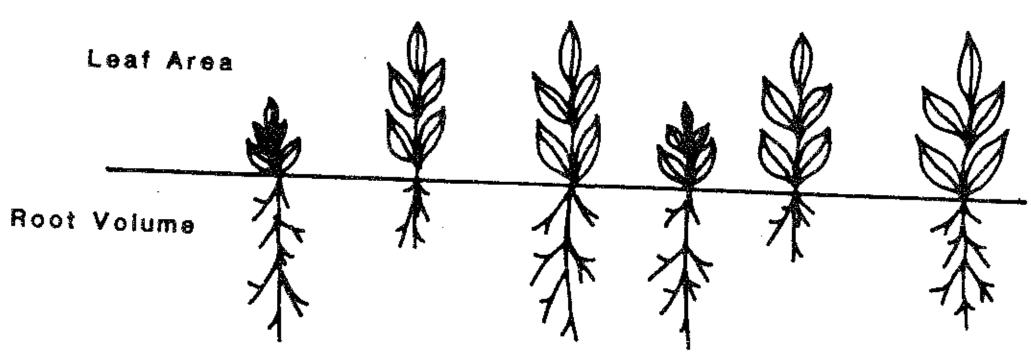


Uncontrolled leaf area removal over time results in declining forage yields by disrupting the energy balance between the above-ground and below-ground portions of the plant.

Reducing the Impacts

A short duration grazing system can reduce the negative impacts exerted by grazing animals by controlling the periods of grazing and non-grazing. Generally, grazing periods of seven days or less followed by rest or regrowth periods of 20 to 40 days will maintain pasture plants in a healthy, vigorous, condition as shown in figure 3.

Figure 3. Forage response under controlled harvest conditions or rotational grazing management.



Controlling leaf area removal and providing adequate recovery periods between harvests helps to maintain pasture plants in a vigorously growing, productive condition.

As a result, available moisture and nutrients are more effectively utilized.

The actual length of the regrowth period will depend on the species being grazed, and climatic conditions influencing growth.

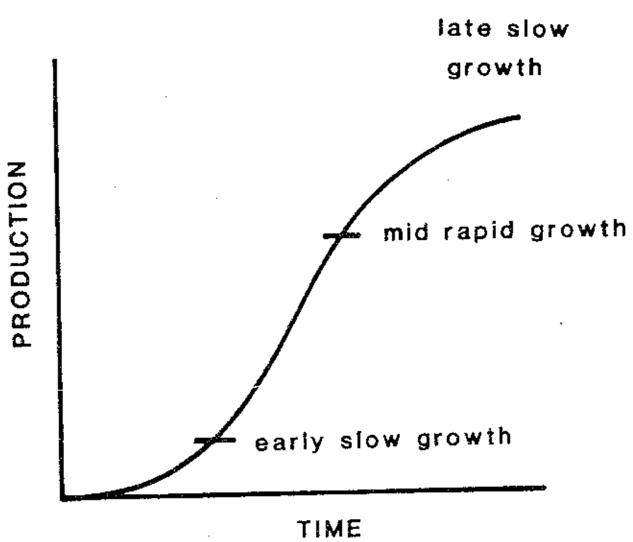
Compared with continuous grazing which over time reduces plant productivity, SDG improves plant productivity and results in increased forage production.

Biological Growth Response

The second step in understanding how SDG increases pasture productivity involves the most important concept—the biological growth response. With few exceptions the rate of growth and development of living organisms progresses through three separate and distinct phases.

As presented in figure 4, there is an early slow growth period, a mid-rapid growth stage, and a late or mature phase characterized by a declining rate of growth.

Figure 4. Biological growth response.



Growth of plants and animals progresses through three separate growth rates represented by an early slow growth period, a mid-rapid growth stage, and a mature or late slow growth period.

The growth and development of silage corn is a good example of this "S" shaped growth response. When corn is planted in early May in the northeast, it is expected to be "knee high by the 4th of July." This time period represents the early slow growth period, with the plants taking about 60 days to accumulate 1½ to 2 feet of growth. During the next 60 days the mid-rapid growth rate is reached and the plants may triple in height. Finally the corn plants mature during the late slow growth period.

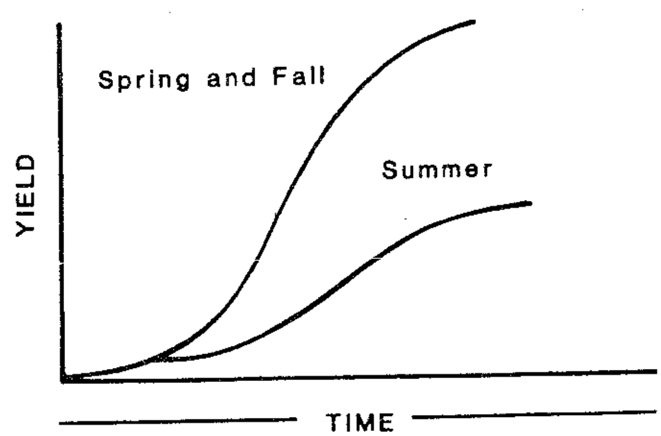
Pasture plants follow a similar pattern of production. However, unlike corn which is harvested only one time at the end of the growing season, pasture plants are subjected to multiple harvests throughout the growing season. Unfortunately, growing conditions do not remain consistent over the season and this adds on additional seasonal factor with which we must be concerned.

Seasonal Patterns of Production

Most forage species used for pasture in the northeast are cool-season plants. These plants begin growth early in the spring when temperatures reach approximately 40°, with maximum growth rates occurring at 70° during May and June. During the mid-season plants enter a period of reduced growth rate or in some cases dormancy. This is due to the nature of the plants and is accentuated by high summer temperatures and low soil moisture levels. With the arrival of cooler temperatures and increased moisture availability associated with fall, the plants again enter a period of increased growth activity.

Although plant development follows the general "S" shaped growth curve, actual growth rate is largely dependent on species and climatic factors, and will vary over time as demonstrated in figure 5.

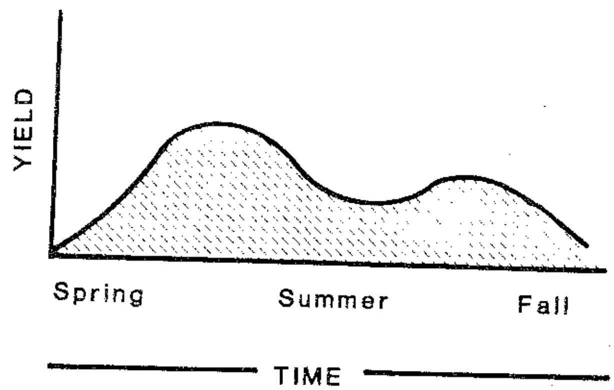
Figure 5. Seasonal differences in biological growth response.



Pasture plants exhibit the "S" shaped biological growth response but it changes with the season. During the more favorable growing conditions of spring and fall growth rates are at a maximum. Summer is a time of reduced growth activity.

Forage yield is related to plant growth rate. Greatest yields occur following periods of maximum growth rate in the spring and fall, with reduced yields resulting from the slower growth rates of mid-summer. Figure 6 represents the seasonal pattern of forage accumulation. Late spring and fall are the two periods of most active growth and greatest productivity, with mid-summer a period of reduced productivity. The fall period, although more productive than mid-summer is not as productive as early spring because among other factors, the shorter days of fall do not provide adequate day length for optimum plant growth.

Figure 6. Seasonal pattern of forage production.



Spring and fall are the most active growth periods for pasture plants, with summer a time of reduced growth rate and declining yield.

Applying the Concepts to Set Up a Grazing System

Although the principles and theories presented to this point are useful in demonstrating the concepts relating to plant growth and grazing influences, in order to apply this information to on-farm situations the elements of time and yield must be expressed in numerical form.

The data presented in figure 7 was collected at Cornell University over a two-year period and demonstrates that increasing the rest interval between harvests can improve dry matter yield.

The "S" shaped growth curve can be readily observed and used to predict yields with given rest periods. Although actual on-farm yields will vary from pasture to pasture, the pattern of production can be predicted and used to organize a short duration grazing system.

The highest levels of production with a SDG system occur when animal feed requirements are in balance with forage production levels and pasture acreage. Although this may at first appear to be a difficult task, the following guide has been prepared to assist with the process. It should be kept in mind however, that once the system is in place some adjustments may be necessary to achieve the highest levels of efficiency.

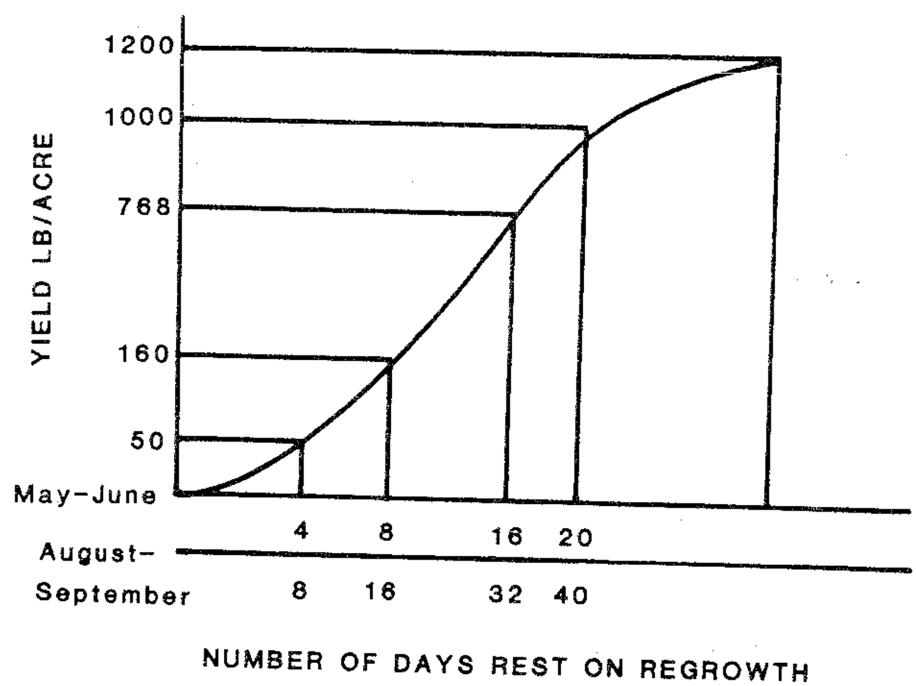
Step 1. Determine your animal units to calculate how much dry matter per day you need. **Rule of thumb:** Grazing animals consume 2.5 lbs. of dry matter (DM) per 100 lbs. of body weight each day:

Example: 150 lb. sheep eats 3.75 lbs. DM/day
1000 lb. growing cattle or dry cow eats 25 lbs. DM/day
1200 lb. dairy cow or a beef cow and her nursing calf eats 30 lbs. DM/day

Step 2. Determine how many acres you have in pasture and calculate it's productivity. Use hay yields to estimate forage availability per grazing rotation after 20 days rest in spring and 40 days rest in summer and fall.
Rule of thumb:

Hay Yield Tons/Acre/Year	3.5	3.0	2.5	2.0	1.5	1.0
Forage Available lbs. DM/ac	1000	850	700	570	425	285

Figure 7. Pasture dry matter yield as a function of time



Maximizing dry matter yields from pasture is a matter of increasing the rest periods between harvests. However, as the summer progresses the rest periods must be increased. During the August-September period rest periods may have to be twice as long as what is needed during the May-June period.

Step 3. Decide how often you want to rotate the livestock i.e., change to a fresh pasture sub-division. Milking herds should not stay on any paddock for more than 3 days, and for maximum milk production, stay only ½ to 1 day. For beef, sheep, horses, llamas, and bison stay no longer than 7 days.

Step 4. Calculate paddock size based on the results from steps 1, 2, and 3.

Example:

1. Assume a dry matter requirement of 300 lb./day:
   80 sheep or
   12 beef cows or
   10 dairy cows
2. Estimated pasture productivity from hay yields: 1000 lb. DM/20-40 day rest period.
3. Grazing period: 4 days per paddock.
4. In order to meet the dry matter requirements of our livestock for a 4 day period: 300 lb. DM/day × 4 days = 1200 lb. DM

   Therefore

   $$\frac{\text{1200 lb. needed}}{\text{1000 lb./acre available}} = \text{1.2 acres/paddock}$$

Step 5. Determine how many paddocks are needed. This is based on the need to have enough paddocks to satisfy the 40 day rest period in summer and fall.

$$\frac{\text{40 days}}{\text{4 days/paddock}} + 1 = \text{11 paddocks}$$

NOTE: Because of the seasonal difference in forage production, paddocks 1-6 will provide the dry matter for grazing during the spring flush (rapid growth) period. Paddocks 7-11 should be cut for hay since if they are not the forage will mature, rapidly decline in quality and stop growth. As the growth rate of all the paddocks slows, they will all be brought into the grazing rotation.

NOTES

WORKSHEET

Animal Class	Number	Average Weight	Dry Matter/ Day

Pasture	Hay Yield	Forage Available	Hay Yield Tons/Acre/Yr	Forage Available per Rotation lbs. DM/Acre
			3.5	1000
			3.0	850
			2.5	700
			2.0	570
			1.5	425
			1.0	285

Animal Class			Grazing Period	
Animal Class/No.	Dry Matter Requirement	Forage Available	Speed of Rotation	Paddock Size

Animal Class/No.	Grazing Period	Paddocks Needed $\left(\frac{40}{s + 1}\right)$

Relative Corn and Hay Yield Estimates for Agricultural Soils Within Each County of New York

Agronomy Mimeo 89-5
W.S. Reid and Karen Rhodes
Department of Agronomy
Cornell University, Ithaca, NY 14853

INTRODUCTION

The soils listed by county are from the USDA COunty Soil Survey publications updated as of 1988, from the manuscripts of the unpublished surveys or from the current soil legends being used for mapping in the counties. The yields shown in this Mimeo were taken from the Master Soils List developed for the Agricultural Land Classification System for New York (Agronomy Mimeo 89-4, W. S. Reid).

DEFINITIONS OF TERMS FOR THE YIELDS LIST FOR AGRICULTURAL SOILS

These are the definitions for the column headings in the soil and yield list. For more information on each soil see the USDA Soil Survey for the county (if published), Soils of New York Landscapes by M. G. Cline and R. L. MArshall, Bulletin 119, Cornell University, 1977, or contact the local SCS or Cooperative Extension office.

Map Symbol 1 - Map symbol is the symbol on modern soil surveys representing the soil name. The symbol is usually a capitol letter followed by a small letter then another capitol letter. The first 2 letters represent the soil name and the last capital letter represents the soil slope. If the county soil survey has not been completed the soil name may be represented by numbers.

Soil Name - A soil name is usually the name of the village, town or place near the site the soil was first officially described. The soil name (and the official soil description) does not have to originate in NY, thus the name may not be from NY. A soil is defined by a range of properties; therefore, the soil at a given site or spot can vary significantly from the typical soil as would be described as representing the soil name. For example, the typical Honeoye soil is described as having a texture in the surface of silt loam, but the surface texture can vary from a fine sandy loam to a silt loam.

Soil Slope - The soil slope is the change in the elevation per 100 feet distance or the percent slope. It is the representative slope for the are not just of a certain spot or line. The slope is currently mapped as ranges such as 0 - 3 (A), 3 - 8 (B), 8 - 15 (C), 15 - 25 (D), 25 - 35 (E) etc., but other ranges have been mapped. The soil slope is a very important property. It is the major factor in soil erosion, but also affects water permeability, ease of cultivation and surface drainage. Usually soil erosion is excessive when soils with greater thaw than about 15% slopes are plowed more than 1 year in 10.

Soil Texture - Soil texture is the percent sand, silt and clay present in a soil. The texture is placed into ranges that have similar properties and are called textural classes. These classes from the most coarse are sands (S), loamy fine sands (LFS), fine sandy loams (FSL), sandy loams (SL), loams (L), silt loams (SiL), clay loams (CL), silty clay loams (SiCL), and clays (C).

The large particles in soils also influence the soil. These particles are gravels (Gr) and gravel sized particles (Channery-CN and Flaggery-Fl), stone (St) are the next larger particles and the largest particles known as boulders (By). If there are a great number of these particles then very (V) or extremely (X) is added to the modifier; for example, Very bouldery (ByV).

Drainage - Soil Drainage is the depth in the soil to which the excess water drains permitting oxygen from the air to penetrate. This depth is determined by observing the soil color. If bright soil colors such as reds, brown and yellow exist, the water drains from the soil. If the soil is a gray color or has a mixture of bright and gray colors called mottles, then the excess water stands within the soil at this depth excluding the sir. These depths are also the depths that plant roots will normally grow. THe soil is described by the terms excessively well drained, well drained (W, greater than 24 inches), moderately well drained (MW, 18 to 24 inches), somewhat poorly drained (SMP, 14 to 18 inches), poorly drained (P, 8 to 14 inches), and very poorly drained (VP, < 8 inches). The soil drainage rankings are very important to the crop species selection, crop yields, and length of hay stands. Alfalfa is not suited on a poorly drained soil and the stand will not normally last longer than 3 years on a somewhat poorly drained soil. Likewise, the excessively well drained soil can normally be worked 1 to 3 days following a 1 inch rain in the spring, well drained, 1 to 3 days, moderately well drained, 3 to 5 days, somewhat poorly drained, 4 to 6 days, poorly drained, about 7 days, and very poorly drained, about mid-July.

pH - A natural soil pH of Hi (high) is, in this case, the result of lime in the soil profile from the parent material making the soil a neutral to alkaline pH (naturally a pH of 7.0 or above) or of Lo (low) pH with no lime in the profile and the natural pH is usually 7.0 or below. A low soil profile pH means that lime has to be added for optimal yields while most of the high profile pH's lime does not have to be added except in rather uncommon situations of sandy surface soils that have leached over the years.

Soil Modifier - Soil modifier is the existence of a soil profile characteristic that changes the properties of a soil from the typical description of that soil. This change can either have an effect on the agronomic properties of the soil, or simply have an effect on the appearance of the soil. For example, a muck soil may be drained or a soil profile may be deeper or shallower than would be normal, or the soil may be over a sandy loam rather than a silt loam parent material, but still be within the limits of its description.

Yrs Corn - Years that corn is permitted within 10 years of a corn-hay rotation as determined by the Universal Soil Loss Equation. This equation uses the slope of the soil, the average length of slope, the soil type, the rainfall intensity and amount, the crop cover and erosion modification practices such as terraces to estimate the erosion. The erosion is then compared to the soil formation rate to determine the soil loss permitted and the number of years that the area can be in corn.

Index for Corn - The relative yield of potential or percent yield potential for corn as compared to the best soils within the state (Hamilton or Genesee with a yield potential of 26 tons/acre)> Thus if the soil is a 0-3% slope Red hook gravelly silt loam with a yield potential of 18 tons per acre, the relative yield is 69% (18/26 times 100).

Yield of Hay - The hay yield is the yield for alfalfa-grass mixtures grown on the better drained soils, but as the yield potential drops below 4 tons/acre, the yield potential is for birdsfoot trefoil. These yields were also estimated from the soil properties for most of the soil types as described for corn because measured yields are not available.

Index for hay - The index is calculated for the hay yields in much the same manner as for corn except the best hay yields are estimated to be 6.0 tons of 15% moisture hay per acre.

TDN Yield - The TDN yield is the yield of total digestible nutrients computed by the formula of [(yield X years of corn X 0.2) + (10 - years corn X yield b=hay X 05)]/10. This produces the potential of the soil to produce Total Digestible Nutrients.

Index for TDN - The TDN index is computed as the other indexes except using the best soil TDN or a value of 4.54.

F Soil - Flooded soil is the rating of yield reduction expected by this soil flooding. THe classes of flooding are R - Rarely flooded, S - Seldom flooded and U - Usually flooded. Not only is the frequency of flooding important in determining yield reduction, but also the types of crops that are likely to be grown at the time of flooding. Early spring (March) flooding has little effect on corn yields, but reduces both the stand and yields of alfalfa.

C Soil - C Soil is Soil Class or whether the soil is in a Prime (P) or Important (I) farmland class. Prime is some of the best land in the United States. Important means that there are large acreages of this productive soil, but may have some major limitation to production such as being very erosive.

Cap Soil - Soil Capability is a measure of the relative limitations to the use of soils. Capability I soils would have no major limitations while 2e soils would have limitations because of erosion. 3W soils would be wet. Not many 4 or 5 capability soils would be in agricultural production without improvements.

G Soil - G Soil is the soil group for the purpose of the Agricultural exemptions to taxation. Group 1 soils are the best while group 8 soils are usually only used for pastures. Group 9 and 10 soils are agriculturally nonproductive groups and have been omitted from this list.

INTEGRATED PEST MANAGEMENT:
A Strategy to Optimize Pest Control Decision-Making for Field Crops and Dairy Cattle

Insects, pathogenic microorganisms, and weeds, collectively referred to as pests, reduce the yield and quality of New York field crops that serve as the primary feedstuffs for dairy cattle. Production of high quality forages, grain and straw at a reasonable cost is a major factor enabling the state's dairy farm to maintain profit margins. Pest induced loses and pest control costs cut into these profits. Dairy cattle are also directly affected by insect and mite pests which decrease animal health and lower milk production.

To make optimal, cost effective and environmentally sound management decisions regarding pest control many growers are using a technique known as Integrated Pest Management (IPM).

Could you benefit from using Integrated Pest Management?

A producer can determine if they need IPM by answering a few questions:

- Are pest problems frequently encountered?
- Are control decisions difficult?
- Can control costs be reduced?
- Are crop yields declining?
- Do I know the pests affecting yield and/or quality of my crops?
- Do I know when pests have and have not reached sufficient numbers to cause crop losses?
- Do I have time to check for pests?
- Do I know the different cultural, biological, chemical control options, and when they are most appropriate and cost effective?

What is Integrated Pest Management?

Integrated Pest Management (IPM) is a crop management strategy that is intended to help growers maximize the economic efficiency, and minimize the potential environmental impact, of pest control decisions. Through IPM, pest control decisions are based on timely, individualized information that is collected on current pest status, stage of development and condition of crops, and weather.

Keys to successful integrated pest management (IPM) are:

1) Early detection of pests.
2) Proper identification of pests and accurate assessment of their potential for economic impact.
3) Continued monitoring of pests, their spread, intensity or population size and frequent re-appraisal of pest damage potential.
4) Employment of appropriate and timely management strategies.

IPM uses relatively simple techniques to collect important, individualized crop and pest data on a regular schedule. This information is then used to measure the potential risk a given pest, or combination of pests, may present to the economic value of a crop; and provide other useful information for pest control decisions. This timely collection of pest, crop and weather information is critical to using IPM as an effective management tool. A key part of the IPM philosophy is that a pest be present at a particular number or amount known to affect crop value, before treatment is justified. This concept involves the use of an economic injury level, i.e. that pest density (number of pests per unit area) at which control measures are economically justified. At these pest levels, the costs of control are less than the expected yield or quality loss, the crop would suffer if control actions were not taken. Employment of pest control options are justified on the basis of preventing pest densities from reaching the economic injury level.

Determining the number of pests present in a crop, at a given point in time, requires that crops be monitored, a practise also referred to as crop scouting, on a regular schedule. Crop monitoring acts as an "early warning system" to identify potentially serious situations before the economic injury level is reached and economic losses occur. When collected early enough, this information on pest status enables producers to make enlightened, cost-effective, management decisions regarding pest control. This information can help facilitate the selection of an appropriate and effective pest control option or combination of options, from a variety of possible alternatives including: cultural, biological, chemical, genetic and physical.

Early detection of pests may also provide opportunities for the use of pest control options that fit well with the timing of other crop production activities; thus providing an additional means of improving the economic and environmental efficiencies of crop production. This pest monitoring information may, for example, provide cues for timing cultivation of row crops, early harvest of alfalfa to minimize pest damage, and use of techniques to enhance the effectiveness of natural predators or parasites of pests. This information may also assist growers to: better time pest control activities at sensitive life stages of pests; "spot treat" isolated weed or insect problems; use lower recommended rates of materials when appropriate, thus reducing total pest control costs; or utilize less toxic or lower residual materials where possible. Timely monitoring of crops also helps to avoid unnecessary pesticide applications and expenditures by identifying situations where pests are either absent or at levels well below those necessary to cause economic loss. Weather data can be used in combination with pest and crop status information to help predict when environmental conditions are favorable for development of specific disease and insect pests.

Properly used, IPM techniques can help maximize profitability of crop production by:

1) Correcting or avoiding crop and pest management problems before economic losses occur;
2) Cutting production expenses by avoiding unnecessary control actions;
3) Helping growers identify the major limiting factors to crop production.

Regular crop monitoring can provide important information on other aspects of crop production such as plant population, crop condition, soil fertility, and drainage. This data can then be used in combination with other crop history information, to help develop long term strategies to minimize the potential for pest problems, and to further optimize the efficiencies of crop production.

(NOTE: An indepth introduction to IPM techniques may be found in the Cornell Field Crops and Soils Handbook. Economic threshold information and control options for pests of field crops is published annually in the Cornell Recommends for Field Crops, similar information for pests of dairy cattle is currently available through the Cornell Pesticide Recommendations).

Maximizing Net Profit, Minimizing Environmental Impact

Once significant pest problems have been detected, correctly identified, and accurately assessed, informed pest management decisions can be made. An effective pest management strategy involves an evaluation of all possible control alternatives; and results in the selection of the most appropriate combination of economically and environmentally sound pest control options. Appropriate pest control techniques for a given situation may vary with such factors as: crop type; relative value or intended use of crop; weather conditions; development stage of crop and pest at time of infestation; presence and diversity of beneficial organisms; and time until harvest. In the past, many pest control alternatives have been under-utilized, and a heavy emphasis has been placed on the use of pesticides. Wise use of pesticides is one of several management options available for controlling pests in a given situation, over reliance on pesticides as the preferred pest control option can lead to: development of pesticide resistance; destruction of beneficial organisms; resurgence of primary pests; or outbreaks of secondary pests, previously held in check by various pesticide-sensitive predators and parasites. Recently, pesticide resistance has been detected for several pests common to dairy farms in New York including: common lambsquarters and smooth pigweed and house flies.

Many IPM practices can be extremely helpful in preventing economic losses from pests. In plants, these may include such practices as: the use of resistant varieties; crop rotation; cultural practices; optimal use of biological control organisms; certified seed; protective seed treatments; timeliness of crop cultivation; improved timing of pesticide applications; and removal or "plow down" of infested plant material. IPM strategies may also be applied to control pests that affect dairy cattle. These IPM strategies may include such practices as: effective organic matter and manure management; improved drainage in and around barns and pastures; optimal timing and application of pesticide treatments to animals or confinement areas; improved timing of insecticide eartag application; use of pest attracting traps and baits; optimal use of biological control agents; and employment of appropriate cultural control practices.

There are a variety of ways that a grower may obtain IPM information depending on individual preferences and resources. Some growers prefer to become IPM trained and monitor crops themselves. Others prefer to obtain this service through participation in grower cooperatives, or hiring agribusiness or private agricultural consultants to provide this information. Cornell Cooperative Extension is also sponsoring pilot IPM programs in many counties. Check with your local cooperative extension agent to see if there is an IPM program in your area. Information on availablility of private agricultural consultants can be obtained by contacting the Professional Agricultural Consultants of New York, Inc. 2269 DeWindt Rd., Newark, NY 14513.

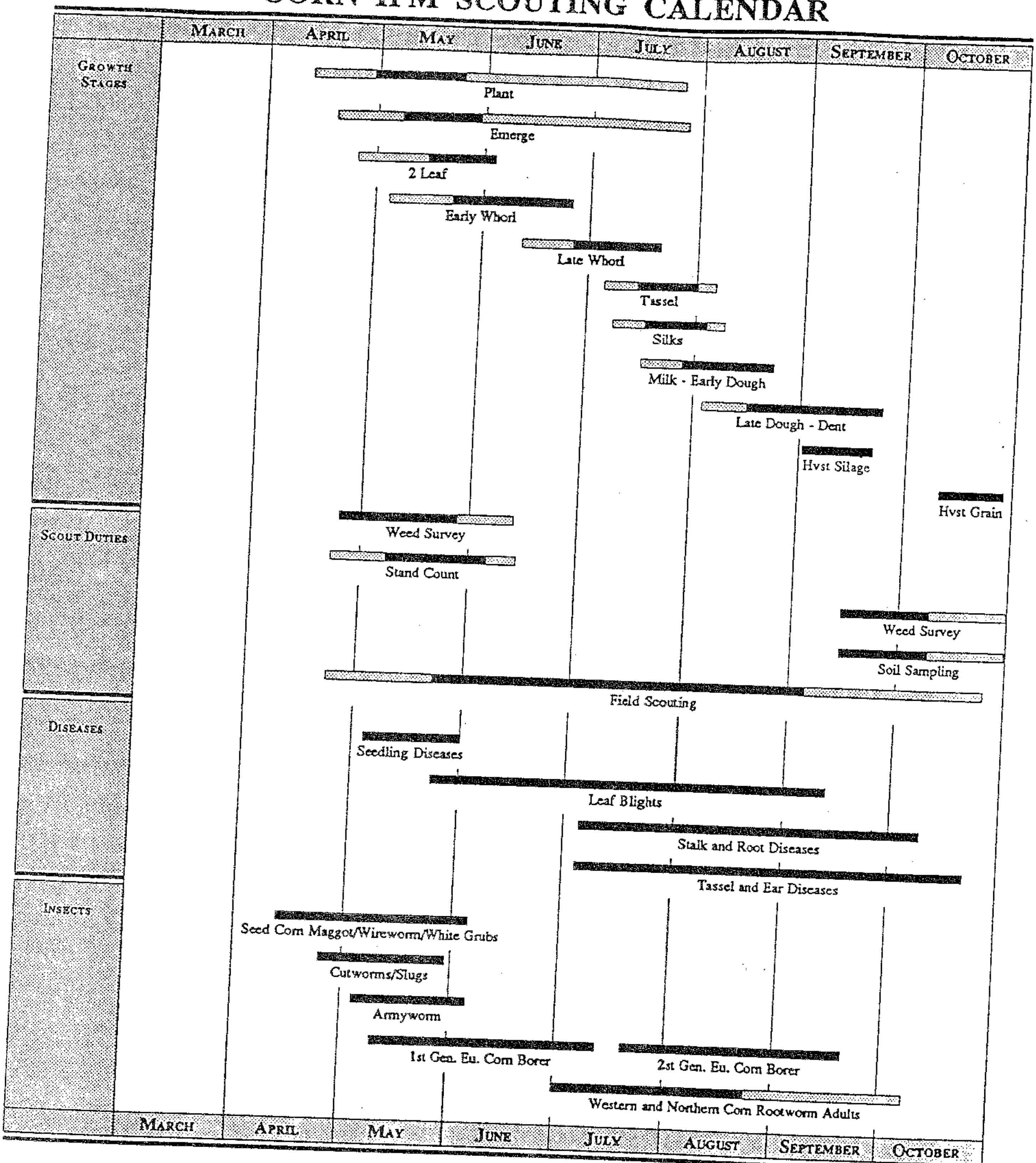
In recent years, Cornell University IPM programs have been developed to help better manage many significant pests on a variety of major crops grown in New York State. At the present time in New York, IPM programs have been developed for managing major pests of: alfalfa, field corn, and dairy cattle. Additional information is available for IPM techniques for wheat and stored grain. Efforts are continually being made by Cornell personnel to expand IPM knowledge and program development to additional commodity areas.

To assist individuals interested in monitoring alfalfa, field corn and dairy cattle for pest problems, scouting calendars are provided as guides to when major pests of these crops generally occur in New York.

For further information on Integrated Pest Management scouting programs or for information on IPM practices for dairy cattle and field crops in New York State, please contact your local county cooperative extension office. Additional IPM information for dairy cattle and field crops may be obtained through the office of the Dairy and Field Crops IPM Coordinator, J. Keith Waldron, Comstock Hall, Cornell University, Ithaca, New York 14853.

J. Keith Waldron, Dairy & Field Crops IPM Coordinator, IPMSupport Group 1/89

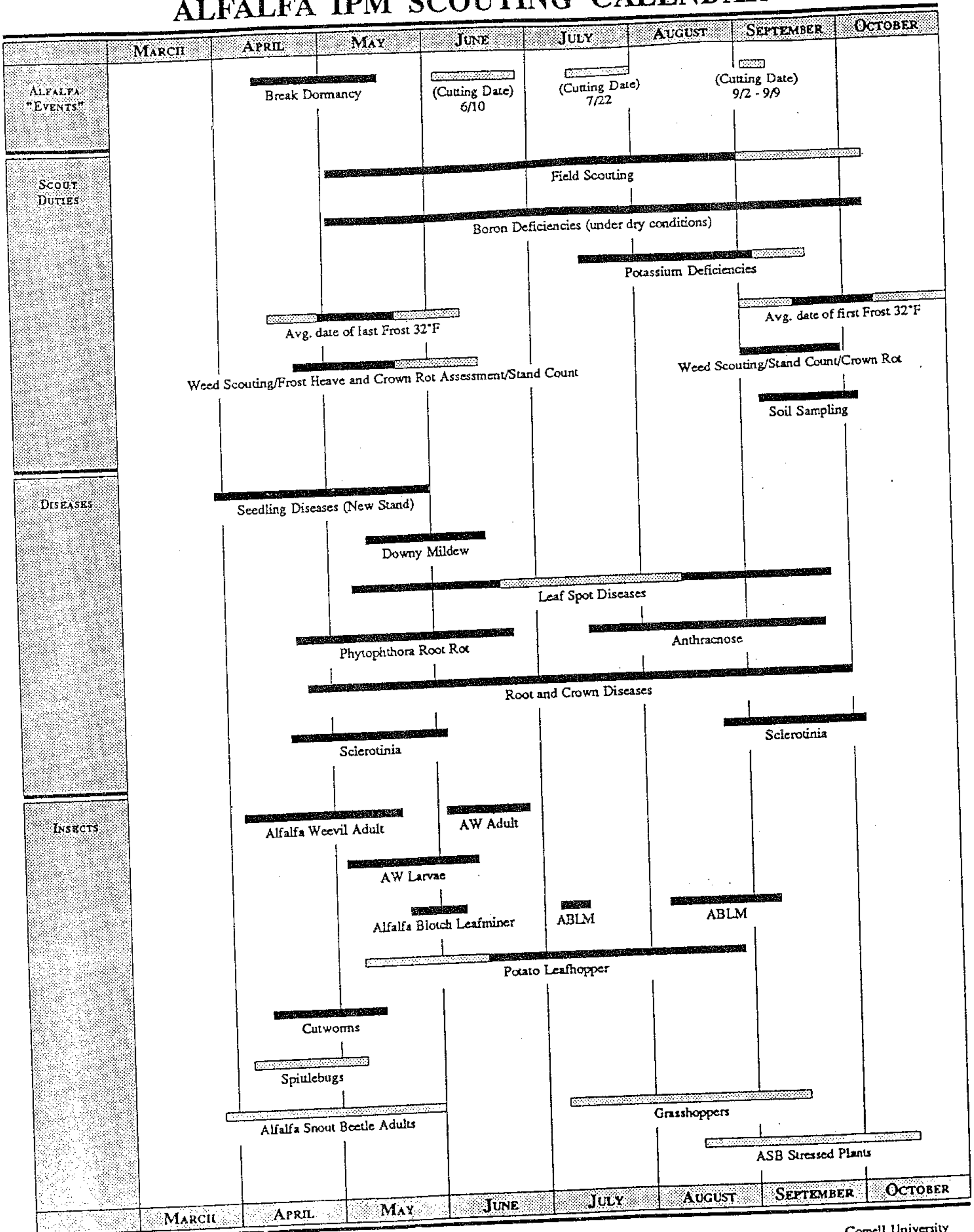
CORN IPM SCOUTING CALENDAR



Developed by: J. K. Waldron, G. E. Bergstrom, E. J. Shields, R. R. Hahn, W. J. Cox

Cornell University
Dairy/Field Crops IPM
5/1989

ALFALFA IPM SCOUTING CALENDAR



Developed by: J. K. Waldron, G. E. Bergstrom, E. J. Shields, R. R. Hahn, R. R. Seaney

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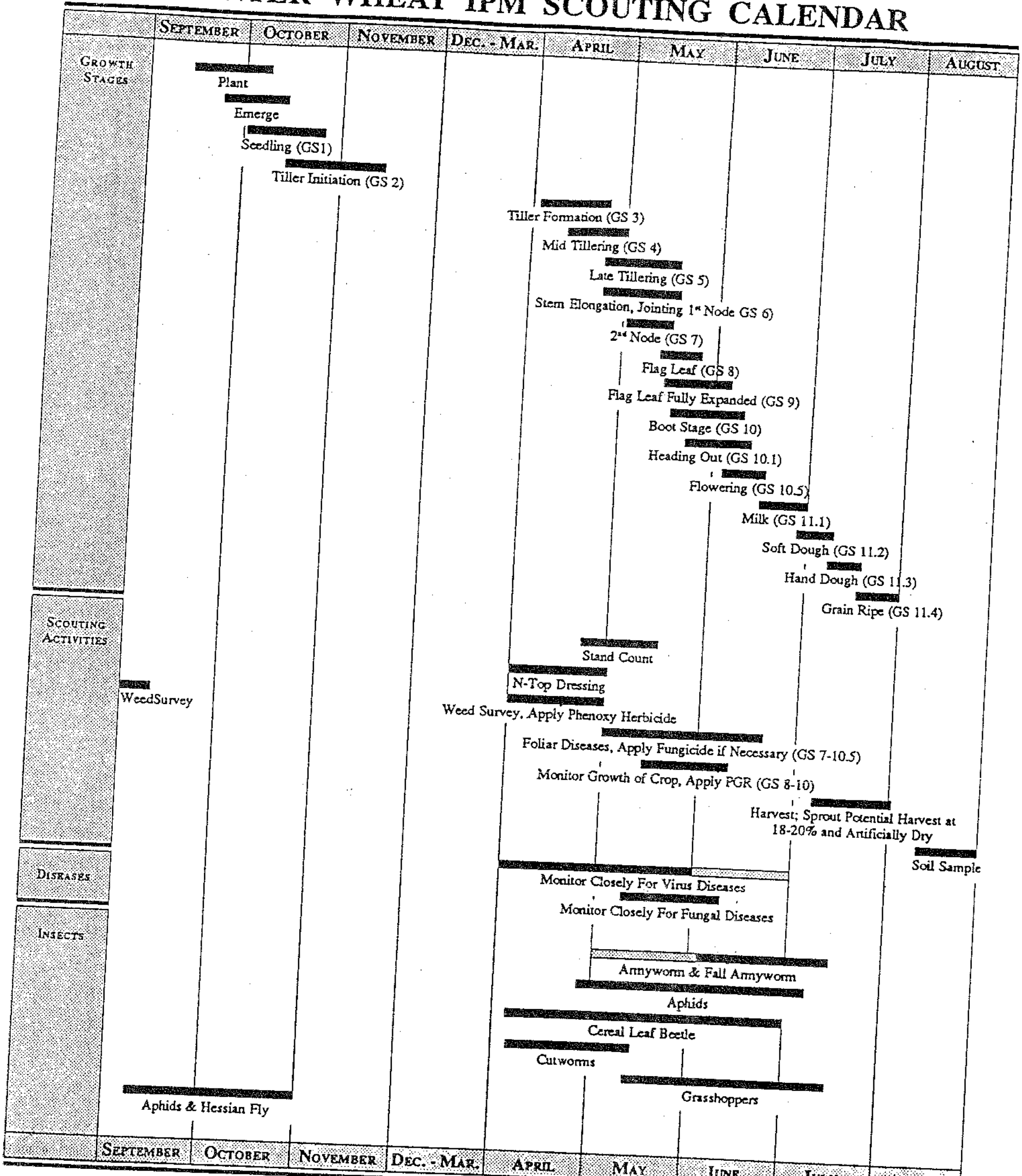
5/1989

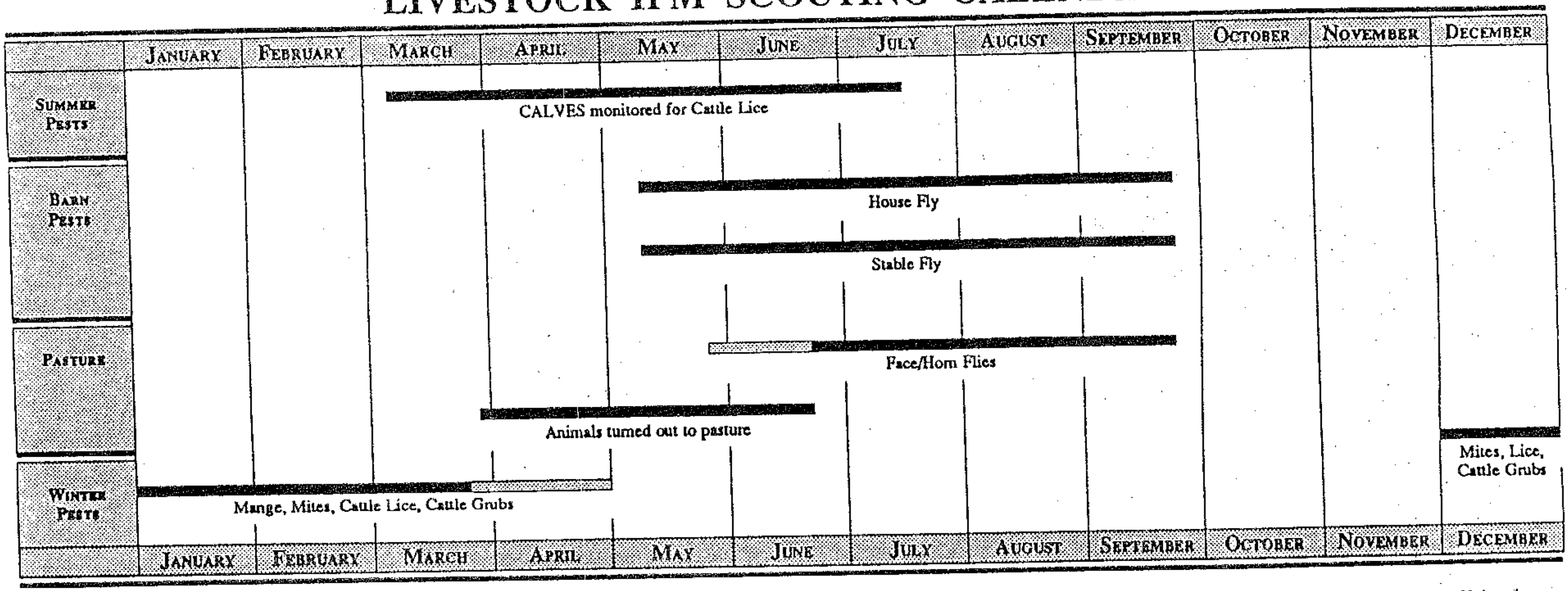
WINTER WHEAT IPM SCOUTING CALENDAR



Developed by: W. J. Cox, G. E. Bergstrom, J. K. Waldron, E. J. Shields, R. R. Hahn

Cornell University
Dairy/Field Crops IPM
5/1989

LIVESTOCK IPM SCOUTING CALENDAR



Developed by: D. A. Rutz, C. J. Geden, J. K. Waldron

Cornell University
Dairy/Field Crops IPM
1/1989

SOILS
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Managing Animal Manure as a Resource Part II: Field Management

by Stuart Klausner and
David Bouldin
Department of Agronomy
Cornell University

On most livestock farms, manure is a major source of plant nutrients. The nutrients in manure can be used very effectively in crop production, and their proper management can materially reduce fertilizer costs.

This publication will discuss the management practices necessary to increase economic benefits from manure. It will also provide examples and work sheets to calculate (1) the quantity of nutrients produced on the farm, (2) an estimate of nitrogen availability, and (3) a rate of application to meet a specified nutrient requirement. This is the second fact sheet of a two-part series. The first one, entitled *Managing Animal Manure as a Resource. Part I: Basic Principles*, should be read first because it covers the basic concepts concerning the nutrient content of manures, the forms and behavior of nitrogen and its effect on crop yield, and the use of manure as a source of plant nutrients.

Nutrient Management

The first priority of a land application program is to incorporate manure into an overall soil fertility program. As a first step, the quantity of nutrients produced should be compared with the total nutrient requirement of your crop rotation. Using this information, a management program can be developed to ensure that manure will supply a major portion of the nutrient requirement.

If the crops require more nutrients than the manure contains you should consider changing management practices to conserve more of the nutrients. On the other hand, if there are more nutrients in the manure than are needed, there is no advantage in changing management to conserve more unless you can sell the excess, or the convenience or environmental concerns outweigh the economic returns, or it enables you to manage other areas more effectively.

Nutrient Production

Work sheet no. 1 will help you approximate the total weight of manure and the pounds of nitrogen, phosphorus, and potassium that are produced each year on your farm. It is worthwhile to have the manure analyzed periodically and to use the results in work sheet no. 1. If an analysis is not available, table 1 can be used to approximate the nutrient content. However, relying too heavily on average values may do more harm than good. Table 1 also provides a rough estimate of the quantity of manure produced each year. The amount collected in a storage can also be determined. Multiply the number of cubic feet of manure in a storage system by 62 (use 55 for very dry manure) and divide by 2,000 to estimate tons. For a liquid storage, multiply cubic feet by 7.5 to obtain gallons.

The example given in this work sheet shows that for an average New York dairy farm about 1,800 tons of manure are produced each year, containing approximately 18,000 pounds of nitrogen, 9,000 pounds of phosphate, and 16,000 pounds of potash.

Nutrient Availability

The nutrients in manure cannot be substituted for the nutrients in commercial fertilizer on a pound-for-pound basis. A portion of the nutrients in manure is not as readily available nor can these nutrients be as efficiently applied as those in fertilizer. Therefore, the amount of fertilizer nitrogen that manure can replace has to be calculated, while the phosphorus and potassium contribution can be measured by soil testing on a regular basis.

Total Manure Nitrogen

Urine — Ammonium N

Time of application	% available
During the growing season as a sidedress injection for row crops.	100
Spring season. Reduce number by 15 for each day incorporation is delayed.	65
All other conditions	0+

Feces — Organic N-mineralized during the year applied.

Dry matter content	% available
Less than 50%	40
Greater than 50%	20

Feces — Organic N (residual)-mineralized from past applications

From manure applied	% available
1 year ago	12
2 years ago	5
3 years ago	2

Figure 1. Estimated availability of the different forms of nitrogen in manure

Nitrogen. Typically, about 50% of the nitrogen (N) in fresh manure is in the ammonium form. The remaining nitrogen is present in an organic form. At every step between production and its utilization by the crop, ammonia is the most valuable and most easily lost component. It is also the most variable component between management systems and, therefore, an analysis of the manure is useful to determine how much ammonia has been conserved.

The calculations that follow assume that the ammonium content was determined from a representative sampling when the manure spreader was being loaded. This procedure accounts for ammonia losses prior to land application. Because the sample cannot be analyzed quickly enough, it is advisable to use this analysis for the next cleanout period. The previous analysis can be used for this time period. For a given feeding and handling system, the ammonium content should not change drastically.

The values in figure 1 can be used to approximate the availability of the different forms of nitrogen. Transfer these values to work sheet no. 2 to estimate availability based on your management practice. To determine the amount of nitrogen that is available from residual organic N, you need to have a previous manure analysis. If unavailable, the current analysis will be a reasonable approximation of what has been applied in the past. If previous rates of application cannot be obtained, skip this calculation. Save your records for the future.

The example in this work sheet points out that the amount of available nitrogen will be low when manure is spread during the fall of the year. The nitrogen value increases considerably by applying and immediately incorporating manure in the spring.

If you don't have a manure analysis, skip work sheet no. 2.

Phosphorus and Potassium. When manure has been applied over a long period of time, phosphorus and potassium can accumulate in the soil. Soil sampling should be done on a regular basis because the soil-test level is a reflection of how much phosphorus and potassium have been applied from past manuring. The soil-test value should then be used to determine the amount of fertilizer needed.

When establishing a crop, phosphorus is used more efficiently if it is banded close to the seed with the planter. Broadcasted manure is not an efficient method of applying phosphorus and, therefore, should not be used to satisfy the entire fertilizer phosphorus (P_2O_5) requirement for crop establishment. When the commercial fertilizer recommendation is less than 40 pounds of P_2O_5 per acre, use a row-placed fertilizer to satisfy the entire requirement. If the recommendations exceed 40 pounds, apply 40 pounds of fertilizer in the row and then use an appropriate rate of manure to make up the difference.

For topdressing hayfields, the phosphorus in broadcasted manure is probably as efficiently used as the phosphorus in broadcasted fertilizer.

Potassium can be used efficiently by plants as either a broadcast or banded application. The fertilizer potassium (K_2O) requirement generally can be met with the appropriate amount of manure.

If manure was applied after the soil test was taken, continue to follow Cornell's P_2O_5 and K_2O fertilizer recommendations. There won't be much change because of a single application. Any change will be reflected in next year's soil-test analysis and will result in an adjustment in the fertilizer recommendation.

Regardless of how much manure is applied, it is usually advisable to use a row-placed starter fertilizer containing N, P_2O_5, and K_2O when establishing a nonlegume crop. The nitrogen can be eliminated when establishing a legume.

Table 1. Approximate quantity of manure produced and most probable average (and range) of dry matter and nutrient composition of manure at the time of land application

Handling system		Manure production per animal unit (1000 lb live wt)	Dry matter	Total N	Available N* A	Available N* B	P_2O_5	K_2O
		tons/yr	(%)	-----	-----	lb/ton	-----	-----
Nonliquid	Dairy	15	15 (12-20)	10 (8-12)	6 (5-8)	4 (3-5)	5 (4-6)	8 (7-10)
	Swine	15	12 (12-18)	12 (10-18)	7 (6-10)	5 (3-6)	9 (8-13)	8 (7-12)
	Poultry	10	50 (35-55)	35 (22-40)	17 (12-18)	9 (6-12)	55 (38-60)	22 (15-25)
		gal/yr†		-----	-----	lb/1000 gal	-----	-----
Liquid	Dairy	5600	10 (8-12)	27 (22-34)	16 (12-20)	10 (7-12)	13 (10-15)	24 (20-30)
	Swine	8200	4 (3-6)	35 (25-50)	22 (16-34)	14 (10-20)	25 (18-30)	20 (15-30)
	Poultry	7600	8 (5-10)	40 (25-50)	27 (16-34)	19 (12-24)	35 (22-48)	15 (10-20)

NOTE: Use these averages if a more accurate estimate is not available. The majority of samples fall within the range given.

* Use column A for spring and early summer applications that are incorporated within 1 day. Use column B for all other conditions.

† Includes dilution water

Table 2. Approximate manure spreader capacities

I. Nonliquid System

a. Spreader volume

measure all dimensions in feet and tenths of feet

1. box spreader: cubic feet = length × width × average depth
2. barrel spreader: cubic feet = 0.393 × d^2(diameter squared) × length
3. irregular shapes: partition the various shapes into rectangles as best as possible and calculate the volume of each as: cubic feet = length × width × depth. Add the volumes together for the total.

b. Spreader capacity

$$\text{tons per load} = \frac{\text{cubic feet} \times 62 \text{ lb per ft}^3}{2000 \text{ lb per ton}}$$ (use 55 lb per ft^3 for extremely dry manure)

II. Liquid System

a. Tank spreader: use manufacturer's data to determine gallon capacity. Estimate the percentage of a full load. There are approximately 8300 lb in 1000 gal

Thousands of gal per load = gal ÷ 1000

Rate of Application

The rate of application should match the nutrient requirements of the crop as closely as possible. In a practical sense, complete utilization is impossible because the ratio of N to P_2O_5 to K_2O in the manure will not match the ratio needed by the crop. On some farms, there are more nutrients than are needed and they will accumulate in the soil. Further accumulation will occur from overapplying fertilizer. On the other hand, when the nutrient needs cannot be met with manure, fertilizer should be used to make up the deficit.

It takes some planning and pencil-pushing to devise an application rate that fits a particular cropping sequence. Work sheet no. 3 is offered to determine this rate. The work sheet is divided into several sections, which deal with tabulating the nutrient requirement of the crop, the nutrient content of the manure, the rate needed to supply the nutrient having the highest priority, and the quantity of commercial fertilizer needed in addition to the manure.

The nitrogen requirement of the crop can be determined by using the appropriate tables in the current issue of *Cornell Recommends for Field Crops*. Use the nitrogen recommendations listed for conditions where manure was not applied, because you need to know how much nitrogen must be added by a combination of manure and fertilizer. The fertilizer P_2O_5 and K_2O requirements can be obtained from a current Cornell soil test or from the fertilizer recommendation tables in *Cornell Recommends for Field Crops*.

As an added step in work sheet no. 3, the number of spreader loads needed to apply a given rate can be calculated. Refer to table 2 for the equations to determine spreader capacity. The manufacturer's data are not always useful if given as a heaped or struck-level capacity. This is hard to maintain because of road spillage.

After the rate for each field is tabulated, add the total amount of manure needed and compare this with the amount produced. If there is excess, and the manure cannot be sold, divide the excess by the number of acres receiving manure and increase the rate accordingly.

General Considerations

When making a capital investment for the purpose of conserving more nutrients, make a careful economic analysis of the change in your management. Nutrient surpluses are not economical unless sold, but an expenditure to markedly improve either environmental quality or your management ability is a good investment.

A series of management guidelines is offered to obtain the maximum benefit from manure.

1. Sound soil conservation practices are an important part of land management. Surface runoff and erosion should be controlled to conserve soil and plant nutrients.
2. It is best to apply manure just before spring planting and to incorporate it as soon as possible to reduce ammonia losses and odors.
3. Conserve the liquid during handling. It has a high plant nutrient content.
4. Fields that require high rates of nitrogen and that are low in phosphorus and potassium should get first priority.

Work Sheet No. 1. Estimating the quantity of manure, nitrogen, phosphate, and potash produced each year

Example: *A dairy farm has 75 cows and 50 heifers. The average weight of cows is 1300 lb and heifers average 500 lb. Manure is handled as a nonliquid. Calculate the amount of manure and quantity of N, P_2O_5, and K_2O produced annually.*

Calculations		*Example*	*Your Farm*
1. Determine the number of 1000 lb animal units.			
a. Total weight = no. of animals × weight per animal (75 cows × 1300 lbs) + (50 heifers × 500 lbs)	=	122,500 lbs	______
b. Animal units = total weight ÷ 1000 lb per unit 122,500 ÷ 1000	=	122.5 units	______
2. Determine the quantity of manure produced or collected annually. Quantity = tons or gal per animal unit from table 1 × number of animal units or 15 tons × 122.5 units Quantity = amount in storage × 12 ÷ months of storage	=	1837 tons	______
3. Determine the nutrient value of the manure. Insert the nutrient value of manure from a recent analysis or from table 1. *Express as lb per ton for a nonliquid system or as lb per 1000 gal for a liquid system.*	N =	10 lbs/ton	______
	P_2O_5 =	5 lbs/ton	______
	K_2O =	9 lbs/ton	______
4. Determine the quantity of N, P_2O_5, and K_2O produced or collected annually. Liquid system: lb per yr = gal per yr from item 2 ÷ 1000 × lb per 1000 gal from item 3. Nonliquid system: lb per yr = tons per yr from item 2 × lb per ton from item 3. 1837 × 10 1837 × 5 1837 × 9	N =	18370 lbs/yr	______
	P_2O_5 =	9185 lbs/yr	______
	K_2O =	16533 lbs/yr	______

5. Similar to fertilizer, manure must be spread as uniformly as possible to avoid erratic results.

6. Reduce the amount of commercial fertilizer added to compensate for the nutrient value of the manure.

7. Avoid spreading manure on hayfields with more than 50% legume. The extra nitrogen can encourage the grasses and weeds at the expense of the legume. Hay stands containing more than 50% grass will respond favorably to the added nitrogen.

8. Avoid overapplication. Nutrient additions in excess of crop needs have no economic value and may enrich our water resources unnecessarily.

When applications must be made in the fall or winter months, we offer the following suggestions.

1. Apply to fields with the least slope and to areas that are not subject to spring flooding.

2. Major problems with late fall and winter spreading are frozen soil or deep snow that makes fields inaccessible. Rutting of wet soils provides runoff channels until spring. Accumulated manure from storages should be spread before the beginning of continuous snow cover. If a snow pack or an ice sheet develops later, it will be over, rather than under, the manure. This practice provides some protection from runoff.

3. For daily spreading, the distance to and the accessibility of fields should be considered. Areas of limited access should be used early in the winter. Easily accessible lands can be used during periods of deep snow cover. This practice helps avoid overloading fields close to the barn.

Nutrient Monitoring

Use Cornell University's soil testing service and follow the recommendations to ensure a proper balance of plant nutrients. Keep a record of nutrient levels in a field and use this information as the basis for adjusting your manure management and soil fertility program.

Work Sheet No. 2. Estimating the amount of nitrogen available for crop production

Example: *A dairy manure sample was taken from a nonliquid storage facility and analyzed. The following calculations show how to estimate the amount of nitrogen that will be available during the growing season from the current manure application and from previous applications. Assume that 25 tons/acre were applied in each of the past 3 years, having an organic N content of 6 lb/ton.*

Calculations

1. Insert the percentage of dry matter and the nitrogen value of the manure from the analysis in lb per ton for a nonliquid system or lb per 1000 gal for a liquid system. *Organic N = Total N − Ammonium N*

	Example	Your Farm
Dry matter	15%	
*Total N**	10 lbs/ton	
Ammonium N	4 lbs/ton	
*Organic N**	6 lbs/ton	

2. Determine the availability of nitrogen during the first year. *Available N = lb of ammonium N or organic N in item 1 × the percentage of availability from figure 1.*

	Time of application	Ammonium N (lb × %)		Organic N (lb × %)		Available N
		- - - - - Quantity available from: - - - - -				
Examples:	Fall	4 x 0	+	6 x .40	=	2.4 lbs/ton
	Spring. Incorp. delayed 2 days	4 x .35	+	6 x .40	=	3.8 lbs/ton
	Spring. Immed. incorporation	4 x .65	+	6 x .40	=	5.0 lbs/ton
Your Farm:			+		=	

3. Determine the availability of nitrogen from previous applications. Omit those years when manure was not applied. *Available N per acre = application rate from previous records in tons or 1000's of gal × lb of organic N per ton or per 1000 gal × percentage of availability from figure 1.*

- - - - - Quantity available from residual organic N from: - - - - -

	1 year ago (rate × N × %)		2 years ago (rate × N × %)		3 years ago (rate × N × %)		Residual N availability
Example:	25 x 6 x .12	+	25 x 6 x .05	+	25 x 6 x .02	=	28.5 lbs/ac
Your Farm:		+		+		=	

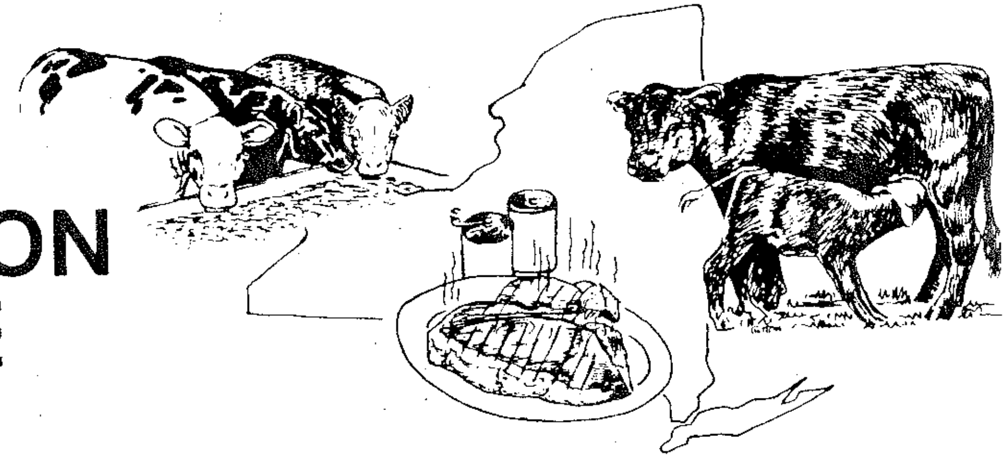
* Some laboratories may report their nitrogen results under the heading "nitrogen" and "ammonium or ammonia N." The larger of the two numbers is total N. Many laboratories do not report organic N simply because it is the difference between total N and ammonium N.

Work Sheet No. 3. Estimating a rate of application

Example: *A dairy farmer wants to apply a nonliquid, lightly bedded manure to a 15-acre cornfield. It will be applied in the early spring and incorporation will be delayed for one week. Manure had been applied often in the past. Determine (1) the rate of application to meet the nitrogen requirement, (2) the amount of P_2O_5 and K_2O applied in order to meet the N requirement, (3) the amount of commercial fertilizer needed, and (4) the number of spreader loads needed to apply the desired application rate.*

Calculations	Example	Your Farm
1. Determine the nutrient needs of the crop.		
a. Crop to be grown	Corn	
b. Insert the quantity of N, P_2O_5 and K_2O needed. *Express as lb per acre.*	N = 120 lbs/ac	
	P_2O_5 = 20 lbs/ac	
	K_2O = 40 lbs/ac	
2. Determine the nutrient value of the manure.		
a. Insert the nutrient content of manure. *Express as lb per ton for a nonliquid system or as lb per 1000 gal for a liquid system.*		
1. available N from work sheet no. 2 or table 1	N = 2.4 lbs/ton	
2. from recent analysis or table 1	P_2O_5 = 5 lbs/ton	
3. from recent analysis or table 1	K_2O = 9 lbs/ton	
3. Determine the rate of application.		
a. Nutrient having the highest priority.	= N	
1. amount of this nutrient to be supplied by manure. *Express as lb needed in item 1b minus amount applied at planting.* 120 - 30 lbs at planting	= 90 lbs/ac	
2. If nitrogen, subtract residual N availability from work sheet 2 — 90 lbs - 29 lb residual	= 61 lbs	
b. Rate of manure needed to supply the nutrient having the highest priority (item 3a ÷ item 2a). *Express in tons per acre for a nonliquid system or as 1000's of gal per acre for a liquid system.* 61 ÷ 2.4 lbs/ton	= 25 tons/ac	
c. Pounds of N, P_2O_5 and K_2O applied per acre with manure.		
1. N value from 2a.1 × manure rate from 3b + residual N availability from work sheet 2. 2.4 x 25 + 29	N = 89 lbs	
2. P_2O_5 value from 2a.2 × manure rate from 3b 5 x 25	P_2O_5 = 125 lbs	
3. K_2O value from 2a.3 × manure rate from 3b 9 x 25	K_2O = 225 lbs	
4. Determine the amount of commercial fertilizer needed from the Cornell Soil Testing Report	*Fertilizer recommendation*	
a. available N from manure = 89 lbs	N = 30 lbs/ac	
b. soil test P value = 9 (high)	P_2O_5 = 20 lbs/ac	
c. soil test K value = 110 (medium)	K_2O = 40 lbs/ac	
5. Determine the number of manure spreader loads required to apply the application rate in 3b.		
a. Spreader capacity *(use equations from table 2).*		
1. liquid system: *(Express in units of 1000's of gal per load.)*	=	
2. nonliquid system: cu ft of spreader = 13.9' x 4.5' x 2.4'	= 150 ft^3	
tons per load = 150 ft^3 x 62 lbs/ft^3 ÷ 2000	= 4.6 tons/load	
b. Number of loads needed.		
1. loads per acre = manure rate in 3b ÷ spreader capacity from 5a — 25 ÷ 4.6	= 5.4 loads/ac	
2. loads per field = loads per acre × acres — 5.4 x 15	= 81 loads	

CORNELL BEEF PRODUCTION REFERENCE MANUAL



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Using Short Duration Grazing to Improve Pasture Production

Introduction

Short duration grazing (SDG) is the most advanced form of what is commonly referred to as rotational grazing. Unlike other grazing systems, SDG combines the principles of ecology, agronomy, plant physiology, and animal nutrition in a management system that promotes high forage yields, enhanced forage quality, increased harvest efficiency, and thus maximizes animal production per acre.

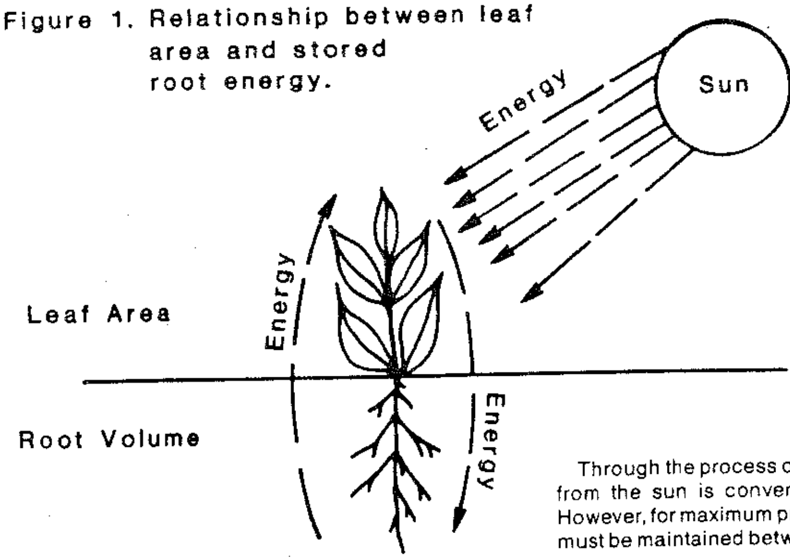
SDG involves subdividing pastures into grazing units called paddocks. The size and number of paddocks depend on the level of pasture productivity, stocking rate of livestock, and the desired speed of rotation. Individual paddocks are grazed one at a time in a planned order with livestock occupying each grazing unit for a period long enough to harvest the available forage, but not so long as to allow grazing of the regrowth of plants previously grazed. Generally, livestock are moved to new paddocks at least once per week. The most intensive systems may move livestock to new paddocks fourteen (14) times per week. After each paddock is grazed to the appropriate stubble height for the plant species present, the livestock are moved to a new paddock. Plants in paddocks previously grazed are then allowed to regrow and regain vigor before being grazed again.

Understanding How Plants Grow

The first step in understanding how SDG increases pasture productivity is to examine how pasture plants grow and respond to grazing.

A forage plant is a living system comprising two connected and dependent parts. There is an above-ground portion consisting of stems and leaves, and a below-ground portion composed of roots and root hairs. The roots and root hairs extract moisture and nutrients from the soil while the green leaves and stems convert light energy from the sun into energy for growth through the process of photosynthesis. (See figure 1.)

Figure 1. Relationship between leaf area and stored root energy.



Through the process of photosynthesis light energy from the sun is converted into energy for growth. However, for maximum productivity an energy balance must be maintained between leaf area and stored root energy.

Darrell L. Emmick, Grassland Specialist, Soil Conservation Service

Surplus energy generated by this process is stored by the plants as carbohydrates or sugars in the roots and stem bases. This stored energy is available for use by the plant to initiate growth in the spring or after defoliation, and to provide nourishment for survival over winter or during other periods of environmental stress. Enhanced levels of growth and production can only occur when an adequate energy balance is maintained between the above-ground and below-ground portions of the plant.

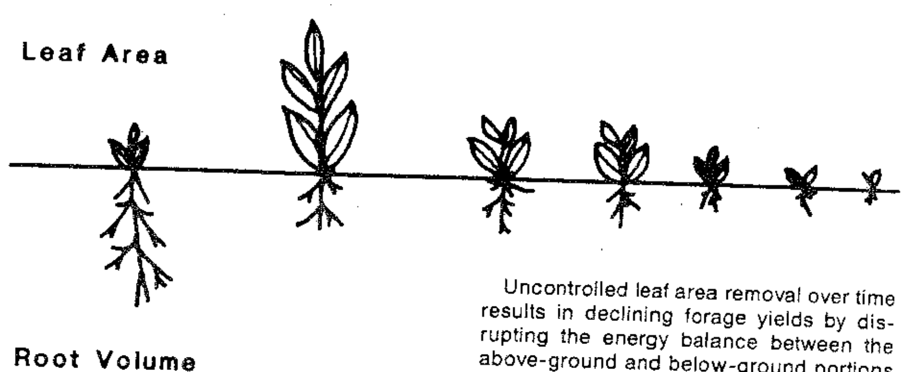
Effects of Improper Use

Although not generally appreciated by livestock producers, the grazing animal exerts an extremely negative impact on plant productivity. Through the forces of defoliation, trampling, and fouling with manure and urine, the grazing animal can influence what plant species can or cannot survive in a given pasture. In some cases the combined impacts of severe defoliation, trampling, and fouling of a pasture have been shown to reduce forage yields by as much as 60% as compared to the hay yield on the same field. Of the three negative impacts previously mentioned, uncontrolled defoliation is the most detrimental to pasture productivity as depicted in figure 2.

Frequent and/or severe removal of leaf area disrupts the normal growth and energy storage pattern and if continued over time reduces plant vigor, yield, and persistance.

Frequent leaf area removal not only reduces the above-ground forage yield, but also causes a decline in root volume. The loss of root volume reduces the plant's ability to extract moisture and nutrients from the soil and thus decreases the plant's capacity for regrowth. As a result, even though adequate soil moisture and fertility levels may be available for rapid plant growth, the plants are unable to respond.

Figure 2. Forage response under uncontrolled harvest conditions or continuous grazing management.

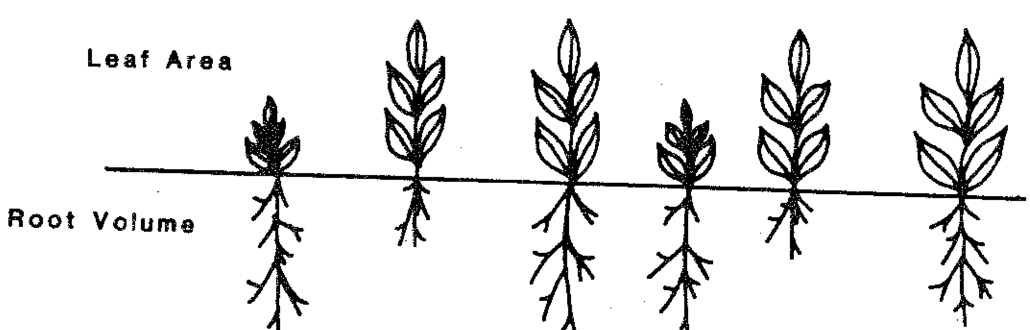


Uncontrolled leaf area removal over time results in declining forage yields by disrupting the energy balance between the above-ground and below-ground portions of the plant.

Reducing the Impacts

A short duration grazing system can reduce the negative impacts exerted by grazing animals by controlling the periods of grazing and non-grazing. Generally, grazing periods of seven days or less followed by rest or regrowth periods of 20 to 40 days will maintain pasture plants in a healthy, vigorous, condition as shown in figure 3.

Figure 3. Forage response under controlled harvest conditions or rotational grazing management.



Controlling leaf area removal and providing adequate recovery periods between harvests helps to maintain pasture plants in a vigorously growing, productive condition.

As a result, available moisture and nutrients are more effectively utilized.

The actual length of the regrowth period will depend on the species being grazed, and climatic conditions influencing growth.

Compared with continuous grazing which over time reduces plant productivity, SDG improves plant productivity and results in increased forage production.

Biological Growth Response

The second step in understanding how SDG increases pasture productivity involves the most important concept—the biological growth response. With few exceptions the rate of growth and development of living organisms progresses through three separate and distinct phases.

As presented in figure 4, there is an early slow growth period, a mid-rapid growth stage, and a late or mature phase characterized by a declining rate of growth.

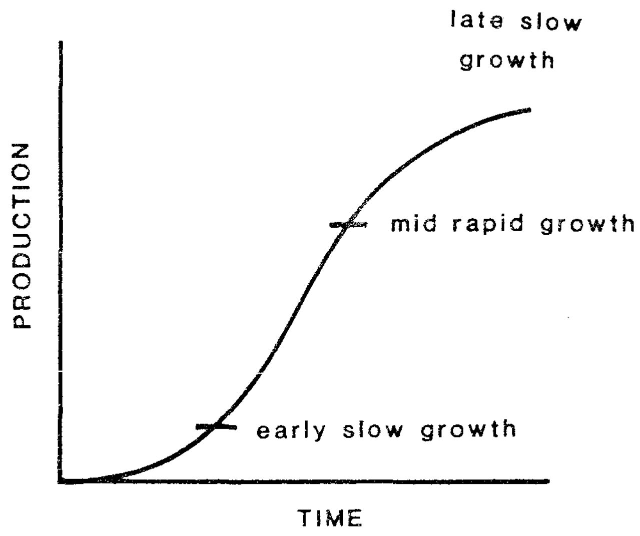
the growing season, pasture plants are subjected to multiple harvests throughout the growing season. Unfortunately, growing conditions do not remain consistent over the season and this adds on additional seasonal factor with which we must be concerned.

Seasonal Patterns of Production

Most forage species used for pasture in the northeast are cool-season plants. These plants begin growth early in the spring when temperatures reach approximately 40°, with maximum growth rates occurring at 70° during May and June. During the mid-season plants enter a period of reduced growth rate or in some cases dormancy. This is due to the nature of the plants and is accentuated by high summer temperatures and low soil moisture levels. With the arrival of cooler temperatures and increased moisture availability associated with fall, the plants again enter a period of increased growth activity.

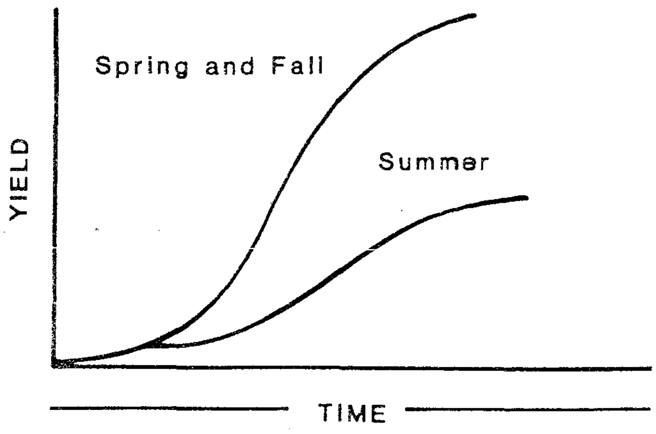
Although plant development follows the general "S" shaped growth curve, actual growth rate is largely dependent on species and climatic factors, and will vary over time as demonstrated in figure 5.

Figure 4. Biological growth response.



Growth of plants and animals progresses through three separate growth rates represented by an early slow growth period, a mid-rapid growth stage, and a mature or late slow growth period.

Figure 5. Seasonal differences in biological growth response.



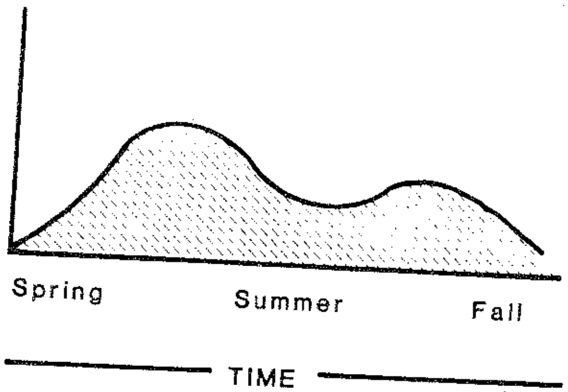
Pasture plants exhibit the "S" shaped biological growth response but it changes with the season. During the more favorable growing conditions of spring and fall growth rates are at a maximum. Summer is a time of reduced growth activity.

The growth and development of silage corn is a good example of this "S" shaped growth response. When corn is planted in early May in the northeast, it is expected to be "knee high by the 4th of July." This time period represents the early slow growth period, with the plants taking about 60 days to accumulate 1½ to 2 feet of growth. During the next 60 days the mid-rapid growth rate is reached and the plants may triple in height. Finally the corn plants mature during the late slow growth period.

Pasture plants follow a similar pattern of production. However, unlike corn which is harvested only one time at the end of

Forage yield is related to plant growth rate. Greatest yields occur following periods of maximum growth rate in the spring and fall, with reduced yields resulting from the slower growth rates of mid-summer. Figure 6 represents the seasonal pattern of forage accumulation. Late spring and fall are the two periods of most active growth and greatest productivity, with mid-summer a period of reduced productivity. The fall period, although more productive than mid-summer is not as productive as early spring because among other factors, the shorter days of fall do not provide adequate day length for optimum plant growth.

Figure 6. Seasonal pattern of forage production.



Spring and fall are the most active growth periods for pasture plants, with summer a time of reduced growth rate and declining yield.

Applying the Concepts to Set Up a Grazing System

Although the principles and theories presented to this point are useful in demonstrating the concepts relating to plant growth and grazing influences, in order to apply this information to on-farm situations the elements of time and yield must be expressed in numerical form.

The data presented in figure 7 was collected at Cornell University over a two-year period and demonstrates that increasing the rest interval between harvests can improve dry matter yield.

The "S" shaped growth curve can be readily observed and used to predict yields with given rest periods. Although actual on-farm yields will vary from pasture to pasture, the pattern of production can be predicted and used to organize a short duration grazing system.

The highest levels of production with a SDG system occur when animal feed requirements are in balance with forage production levels and pasture acreage. Although this may at first appear to be a difficult task, the following guide has been prepared to assist with the process. It should be kept in mind however, that once the system is in place some adjustments may be necessary to achieve the highest levels of efficiency.

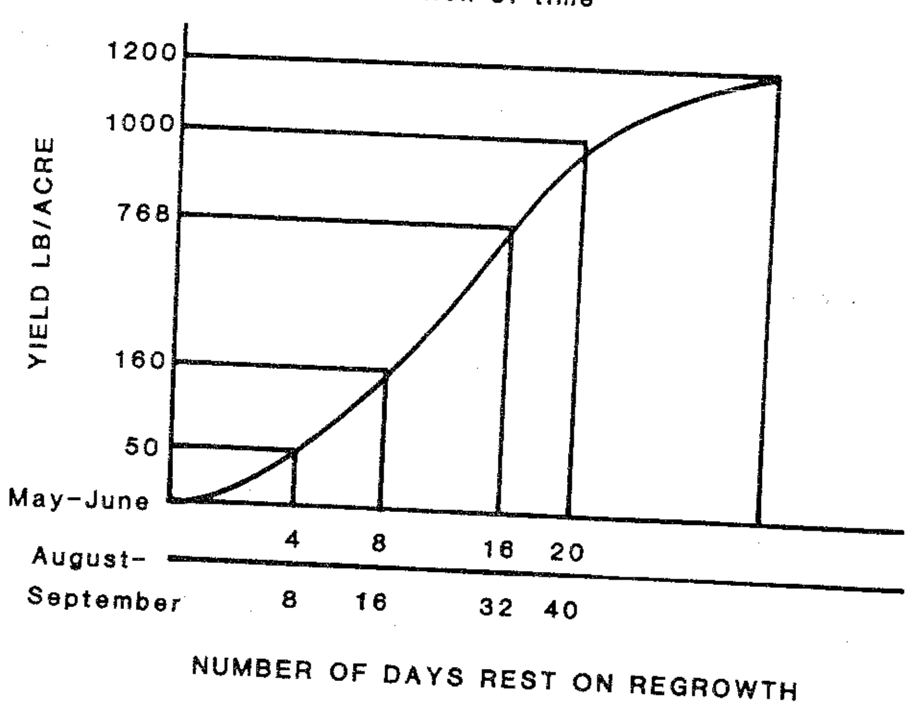
Step 1. Determine your animal units to calculate how much dry matter per day you need. **Rule of thumb:** Grazing animals consume 2.5 lbs. of dry matter (DM) per 100 lbs. of body weight each day:

Example: 150 lb. sheep eats 3.75 lbs. DM/day
1000 lb. growing cattle or dry cow eats 25 lbs. DM/day
1200 lb. dairy cow or a beef cow and her nursing calf eats 30 lbs. DM/day

Step 2. Determine how many acres you have in pasture and calculate it's productivity. Use hay yields to estimate forage availability per grazing rotation after 20 days rest in spring and 40 days rest in summer and fall.
Rule of thumb:

Hay Yield Tons/Acre/Year	3.5	3.0	2.5	2.0	1.5	1.0
Forage Available lbs. DM/ac	1000	850	700	570	425	285

Figure 7. Pasture dry matter yield as a function of time



Maximizing dry matter yields from pasture is a matter of increasing the rest periods between harvests. However, as the summer progresses the rest periods must be increased. During the August-September period rest periods may have to be twice as long as what is needed during the May-June period.

Step 3. Decide how often you want to rotate the livestock i.e., change to a fresh pasture sub-division. Milking herds should not stay on any paddock for more than 3 days, and for maximum milk production, stay only ½ to 1 day. For beef, sheep, horses, llamas, and bison stay no longer than 7 days.

Step 4. Calculate paddock size based on the results from steps 1, 2, and 3.

Example:

1. Assume a dry matter requirement of 300 lb./day:
   80 sheep or
   12 beef cows or
   10 dairy cows
2. Estimated pasture productivity from hay yields: 1000 lb. DM/20-40 day rest period.
3. Grazing period: 4 days per paddock.
4. In order to meet the dry matter requirements of our livestock for a 4 day period: 300 lb. DM/day × 4 days = 1200 lb. DM
   Therefore

$$\frac{\text{1200 lb. needed}}{\text{1000 lb./acre available}} = \text{1.2 acres/paddock}$$

Step 5. Determine how many paddocks are needed. This is based on the need to have enough paddocks to satisfy the 40 day rest period in summer and fall.

$$\frac{\text{40 days}}{\text{4 days/paddock}} + 1 = \text{11 paddocks}$$

NOTE: Because of the seasonal difference in forage production, paddocks 1-6 will provide the dry matter for grazing during the spring flush (rapid growth) period. Paddocks 7-11 should be cut for hay since if they are not the forage will mature, rapidly decline in quality and stop growth. As the growth rate of all the paddocks slows, they will all be brought into the grazing rotation.

NOTES

WORKSHEET

Animal Class	Number	Average Weight	Dry Matter/ Day

Pasture	Hay Yield	Forage Available	Hay Yield Tons/Acre/Yr	Forage Available per Rotation lbs. DM/Acre
			3.5	1000
			3.0	850
			2.5	700
			2.0	570
			1.5	425
			1.0	285

Animal Class			Grazing Period	
Animal Class/No.	Dry Matter Requirement	Forage Available	Speed of Rotation	Paddock Size

Animal Class/No.	Grazing Period	Paddocks Needed $\left(\frac{40}{s+1}\right)$

Relative Corn and Hay Yield Estimates for Agricultural Soils Within Each County of New York

Agronomy Mimeo 89-5
W.S. Reid and Karen Rhodes
Department of Agronomy
Cornell University, Ithaca, NY 14853

INTRODUCTION

The soils listed by county are from the USDA COunty Soil Survey publications updated as of 1988, from the manuscripts of the unpublished surveys or from the current soil legends being used for mapping in the counties. The yields shown in this Mimeo were taken from the Master Soils List developed for the Agricultural Land Classification System for New York (Agronomy Mimeo 89-4, W. S. Reid).

DEFINITIONS OF TERMS FOR THE YIELDS LIST FOR AGRICULTURAL SOILS

These are the definitions for the column headings in the soil and yield list. For more information on each soil see the USDA Soil Survey for the county (if published), Soils of New York Landscapes by M. G. Cline and R. L. MArshall, Bulletin 119, Cornell University, 1977, or contact the local SCS or Cooperative Extension office.

<u>Map Symbol 1</u> - Map symbol is the symbol on modern soil surveys representing the soil name. The symbol is usually a capitol letter followed by a small letter then another capitol letter. The first 2 letters represent the soil name and the last capital letter represents the soil slope. If the county soil survey has not been completed the soil name may be represented by numbers.

<u>Soil Name</u> - A soil name is usually the name of the village, town or place near the site the soil was first officially described. The soil name (and the official soil description) does not have to originate in NY, thus the name may not be from NY. A soil is defined by a range of properties; therefore, the soil at a given site or spot can vary significantly from the typical soil as would be described as representing the soil name. For example, the typical Honeoye soil is described as having a texture in the surface of silt loam, but the surface texture can vary from a fine sandy loam to a silt loam.

<u>Soil Slope</u> - The soil slope is the change in the elevation per 100 feet distance or the percent slope. It is the representative slope for the are not just of a certain spot or line. The slope is currently mapped as ranges such as 0 - 3 (A), 3 - 8 (B), 8 - 15 (C), 15 - 25 (D), 25 - 35 (E) etc., but other ranges have been mapped. The soil slope is a very important property. It is the major factor in soil erosion, but also affects water permeability, ease of cultivation and surface drainage. Usually soil erosion is excessive when soils with greater thaw than about 15% slopes are plowed more than 1 year in 10.

Soil Texture - Soil texture is the percent sand, silt and clay present in a soil. The texture is placed into ranges that have similar properties and are called textural classes. These classes from the most coarse are sands (S), loamy fine sands (LFS), fine sandy loams (FSL), sandy loams (SL), loams (L), silt loams (SiL), clay loams (CL), silty clay loams (SiCL), and clays (C).

The large particles in soils also influence the soil. These particles are gravels (Gr) and gravel sized particles (Channery-CN and Flaggery-Fl), stone (St) are the next larger particles and the largest particles known as boulders (By). If there are a great number of these particles then very (V) or extremely (X) is added to the modifier; for example, Very bouldery (ByV).

Drainage - Soil Drainage is the depth in the soil to which the excess water drains permitting oxygen from the air to penetrate. This depth is determined by observing the soil color. If bright soil colors such as reds, brown and yellow exist, the water drains from the soil. If the soil is a gray color or has a mixture of bright and gray colors called mottles, then the excess water stands within the soil at this depth excluding the sir. These depths are also the depths that plant roots will normally grow. THe soil is described by the terms excessively well drained, well drained (W, greater than 24 inches), moderately well drained (MW, 18 to 24 inches), somewhat poorly drained (SMP, 14 to 18 inches), poorly drained (P, 8 to 14 inches), and very poorly drained (VP, < 8 inches). The soil drainage rankings are very important to the crop species selection, crop yields, and length of hay stands. Alfalfa is not suited on a poorly drained soil and the stand will not normally last longer than 3 years on a somewhat poorly drained soil. Likewise, the excessively well drained soil can normally be worked 1 to 3 days following a 1 inch rain in the spring, well drained, 1 to 3 days, moderately well drained, 3 to 5 days, somewhat poorly drained, 4 to 6 days, poorly drained, about 7 days, and very poorly drained, about mid-July.

pH - A natural soil pH of Hi (high) is, in this case, the result of lime in the soil profile from the parent material making the soil a neutral to alkaline pH (naturally a pH of 7.0 or above) or of Lo (low) pH with no lime in the profile and the natural pH is usually 7.0 or below. A low soil profile pH means that lime has to be added for optimal yields while most of the high profile pH's lime does not have to be added except in rather uncommon situations of sandy surface soils that have leached over the years.

Soil Modifier - Soil modifier is the existence of a soil profile characteristic that changes the properties of a soil from the typical description of that soil. This change can either have an effect on the agronomic properties of the soil, or simply have an effect on the appearance of the soil. For example, a muck soil may be drained or a soil profile may be deeper or shallower than would be normal, or the soil may be over a sandy loam rather than a silt loam parent material, but still be within the limits of its description.

Yrs Corn - Years that corn is permitted within 10 years of a corn-hay rotation as determined by the Universal Soil Loss Equation. This equation uses the slope of the soil, the average length of slope, the soil type, the rainfall intensity and amount, the crop cover and erosion modification practices such as terraces to estimate the erosion. The erosion is then compared to the soil formation rate to determine the soil loss permitted and the number of years that the area can be in corn.

Index for Corn - The relative yield of potential or percent yield potential for corn as compared to the best soils within the state (Hamilton or Genesee with a yield potential of 26 tons/acre)> Thus if the soil is a 0-3% slope Red hook gravelly silt loam with a yield potential of 18 tons per acre, the relative yield is 69% (18/26 times 100).

Yield of Hay - The hay yield is the yield for alfalfa-grass mixtures grown on the better drained soils, but as the yield potential drops below 4 tons/acre, the yield potential is for birdsfoot trefoil. These yields were also estimated from the soil properties for most of the soil types as described for corn because measured yields are not available.

Index for hay - The index is calculated for the hay yields in much the same manner as for corn except the best hay yields are estimated to be 6.0 tons of 15% moisture hay per acre.

TDN Yield - The TDN yield is the yield of total digestible nutrients computed by the formula of [(yield X years of corn X 0.2) + (10 - years corn X yield b=hay X 05)]/10. This produces the potential of the soil to produce Total Digestible Nutrients.

Index for TDN - The TDN index is computed as the other indexes except using the best soil TDN or a value of 4.54.

F Soil - Flooded soil is the rating of yield reduction expected by this soil flooding. THe classes of flooding are R - Rarely flooded, S - Seldom flooded and U - Usually flooded. Not only is the frequency of flooding important in determining yield reduction, but also the types of crops that are likely to be grown at the time of flooding. Early spring (March) flooding has little effect on corn yields, but reduces both the stand and yields of alfalfa.

C Soil - C Soil is Soil Class or whether the soil is in a Prime (P) or Important (I) farmland class. Prime is some of the best land in the United States. Important means that there are large acreages of this productive soil, but may have some major limitation to production such as being very erosive.

Cap Soil - Soil Capability is a measure of the relative limitations to the use of soils. Capability I soils would have no major limitations while 2e soils would have limitations because of erosion. 3W soils would be wet. Not many 4 or 5 capability soils would be in agricultural production without improvements.

G Soil - G Soil is the soil group for the purpose of the Agricultural exemptions to taxation. Group 1 soils are the best while group 8 soils are usually only used for pastures. Group 9 and 10 soils are agriculturally nonproductive groups and have been omitted from this list.

INTEGRATED PEST MANAGEMENT:
A Strategy to Optimize Pest Control Decision-Making for Field Crops and Dairy Cattle

Insects, pathogenic microorganisms, and weeds, collectively referred to as pests, reduce the yield and quality of New York field crops that serve as the primary feedstuffs for dairy cattle. Production of high quality forages, grain and straw at a reasonable cost is a major factor enabling the state's dairy farm to maintain profit margins. Pest induced loses and pest control costs cut into these profits. Dairy cattle are also directly affected by insect and mite pests which decrease animal health and lower milk production.

To make optimal, cost effective and environmentally sound management decisions regarding pest control many growers are using a technique known as Integrated Pest Management (IPM).

Could you benefit from using Integrated Pest Management?

A producer can determine if they need IPM by answering a few questions:

- Are pest problems frequently encountered?
- Are control decisions difficult?
- Can control costs be reduced?
- Are crop yields declining?
- Do I know the pests affecting yield and/or quality of my crops?
- Do I know when pests have and have not reached sufficient numbers to cause crop losses?
- Do I have time to check for pests?
- Do I know the different cultural, biological, chemical control options, and when they are most appropriate and cost effective?

What is Integrated Pest Management?

Integrated Pest Management (IPM) is a crop management strategy that is intended to help growers maximize the economic efficiency, and minimize the potential environmental impact, of pest control decisions. Through IPM, pest control decisions are based on timely, individualized information that is collected on current pest status, stage of development and condition of crops, and weather.

Keys to successful integrated pest management (IPM) are:

1) Early detection of pests.
2) Proper identification of pests and accurate assessment of their potential for economic impact.
3) Continued monitoring of pests, their spread, intensity or population size and frequent reappraisal of pest damage potential.
4) Employment of appropriate and timely management strategies.

IPM uses relatively simple techniques to collect important, individualized crop and pest data on a regular schedule. This information is then used to measure the potential risk a given pest, or combination of pests, may present to the economic value of a crop; and provide other useful information for pest control decisions. This timely collection of pest, crop and weather information is critical to using IPM as an effective management tool. A key part of the IPM philosophy is that a pest be present at a particular number or amount known to affect crop value, before treatment is justified. This concept involves the use of an economic injury level, i.e. that pest density (number of pests per unit area) at which control measures are economically justified. At these pest levels, the costs of control are less than the expected yield or quality loss, the crop would suffer if control actions were not taken. Employment of pest control options are justified on the basis of preventing pest densities from reaching the economic injury level.

Determining the number of pests present in a crop, at a given point in time, requires that crops be monitored, a practise also referred to as crop scouting, on a regular schedule. Crop monitoring acts as an "early warning system" to identify potentially serious situations before the economic injury level is reached and economic losses occur. When collected early enough, this information on pest status enables producers to make enlightened, cost-effective, management decisions regarding pest control. This information can help facilitate the selection of an appropriate and effective pest control option or combination of options, from a variety of possible alternatives including: cultural, biological, chemical, genetic and physical.

Early detection of pests may also provide opportunities for the use of pest control options that fit well with the timing of other crop production activities; thus providing an additional means of improving the economic and environmental efficiencies of crop production. This pest monitoring information may, for example, provide cues for timing cultivation of row crops, early harvest of alfalfa to minimize pest damage, and use of techniques to enhance the effectiveness of natural predators or parasites of pests. This information may also assist growers to: better time pest control activities at sensitive life stages of pests; "spot treat" isolated weed or insect problems; use lower recommended rates of materials when appropriate, thus reducing total pest control costs; or utilize less toxic or lower residual materials where possible. Timely monitoring of crops also helps to avoid unnecessary pesticide applications and expenditures by identifying situations where pests are either absent or at levels well below those necessary to cause economic loss. Weather data can be used in combination with pest and crop status information to help predict when environmental conditions are favorable for development of specific disease and insect pests.

Properly used, IPM techniques can help maximize profitability of crop production by:

1) Correcting or avoiding crop and pest management problems before economic losses occur;
2) Cutting production expenses by avoiding unnecessary control actions;
3) Helping growers identify the major limiting factors to crop production.

Regular crop monitoring can provide important information on other aspects of crop production such as plant population, crop condition, soil fertility, and drainage. This data can then be used in combination with other crop history information, to help develop long term strategies to minimize the potential for pest problems, and to further optimize the efficiencies of crop production.

(**NOTE:** An indepth introduction to IPM techniques may be found in the Cornell Field Crops and Soils Handbook. Economic threshold information and control options for pests of field crops is published annually in the Cornell Recommends for Field Crops, similar information for pests of dairy cattle is currently available through the Cornell Pesticide Recommendations).

Maximizing Net Profit, Minimizing Environmental Impact

Once significant pest problems have been detected, correctly identified, and accurately assessed, informed pest management decisions can be made. An effective pest management strategy involves an evaluation of all possible control alternatives; and results in the selection of the most appropriate combination of economically and environmentally sound pest control options. Appropriate pest control techniques for a given situation may vary with such factors as: crop type; relative value or intended use of crop; weather conditions; development stage of crop and pest at time of infestation; presence and diversity of beneficial organisms; and time until harvest. In the past, many pest control alternatives have been under-utilized, and a heavy emphasis has been placed on the use of pesticides. Wise use of pesticides is one of several management options available for controlling pests in a given situation, over reliance on pesticides as the preferred pest control option can lead to: development of pesticide resistance; destruction of beneficial organisms; resurgence of primary pests; or outbreaks of secondary pests, previously held in check by various pesticide-sensitive predators and parasites. Recently, pesticide resistance has been detected for several pests common to dairy farms in New York including: common lambsquarters and smooth pigweed and house flies.

Many IPM practices can be extremely helpful in preventing economic losses from pests. In plants, these may include such practices as: the use of resistant varieties; crop rotation; cultural practices; optimal use of biological control organisms; certified seed; protective seed treatments; timeliness of crop cultivation; improved timing of pesticide applications; and removal or "plow down" of infested plant material. IPM strategies may also be applied to control pests that affect dairy cattle. These IPM strategies may include such practices as: effective organic matter and manure management; improved drainage in and around barns and pastures; optimal timing and application of pesticide treatments to animals or confinement areas; improved timing of insecticide eartag application; use of pest attracting traps and baits; optimal use of biological control agents; and employment of appropriate cultural control practices.

There are a variety of ways that a grower may obtain IPM information depending on individual preferences and resources. Some growers prefer to become IPM trained and monitor crops themselves. Others prefer to obtain this service through participation in grower cooperatives, or hiring agribusiness or private agricultural consultants to provide this information. Cornell Cooperative Extension is also sponsoring pilot IPM programs in many counties. Check with your local cooperative extension agent to see if there is an IPM program in your area. Information on availablility of private agricultural consultants can be obtained by contacting the Professional Agricultural Consultants of New York, Inc. 2269 DeWindt Rd., Newark, NY 14513.

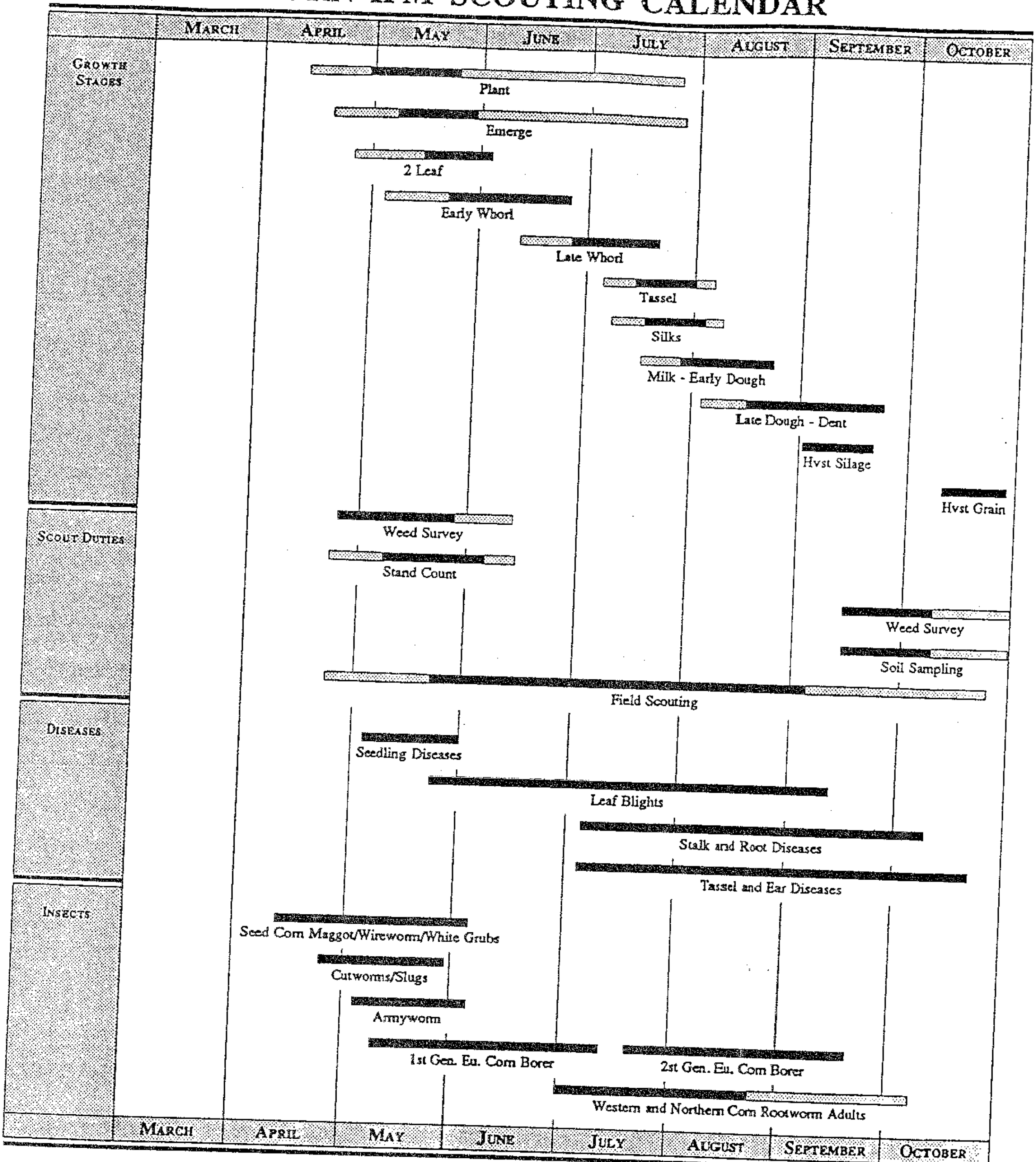
In recent years, Cornell University IPM programs have been developed to help better manage many significant pests on a variety of major crops grown in New York State. At the present time in New York, IPM programs have been developed for managing major pests of: alfalfa, field corn, and dairy cattle. Additional information is available for IPM techniques for wheat and stored grain. Efforts are continually being made by Cornell personnel to expand IPM knowledge and program development to additional commodity areas.

To assist individuals interested in monitoring alfalfa, field corn and dairy cattle for pest problems, scouting calendars are provided as guides to when major pests of these crops generally occur in New York.

For further information on Integrated Pest Management scouting programs or for information on IPM practices for dairy cattle and field crops in New York State, please contact your local county cooperative extension office. Additional IPM information for dairy cattle and field crops may be obtained through the office of the Dairy and Field Crops IPM Coordinator, J. Keith Waldron, Comstock Hall, Cornell University, Ithaca, New York 14853.

J. Keith Waldron, Dairy & Field Crops IPM Coordinator, IPMSupport Group 1/89

CORN IPM SCOUTING CALENDAR



Developed by: J. K. Waldron, G. E. Bergstrom, E. J. Shields, R. R. Hahn, W. J. Cox

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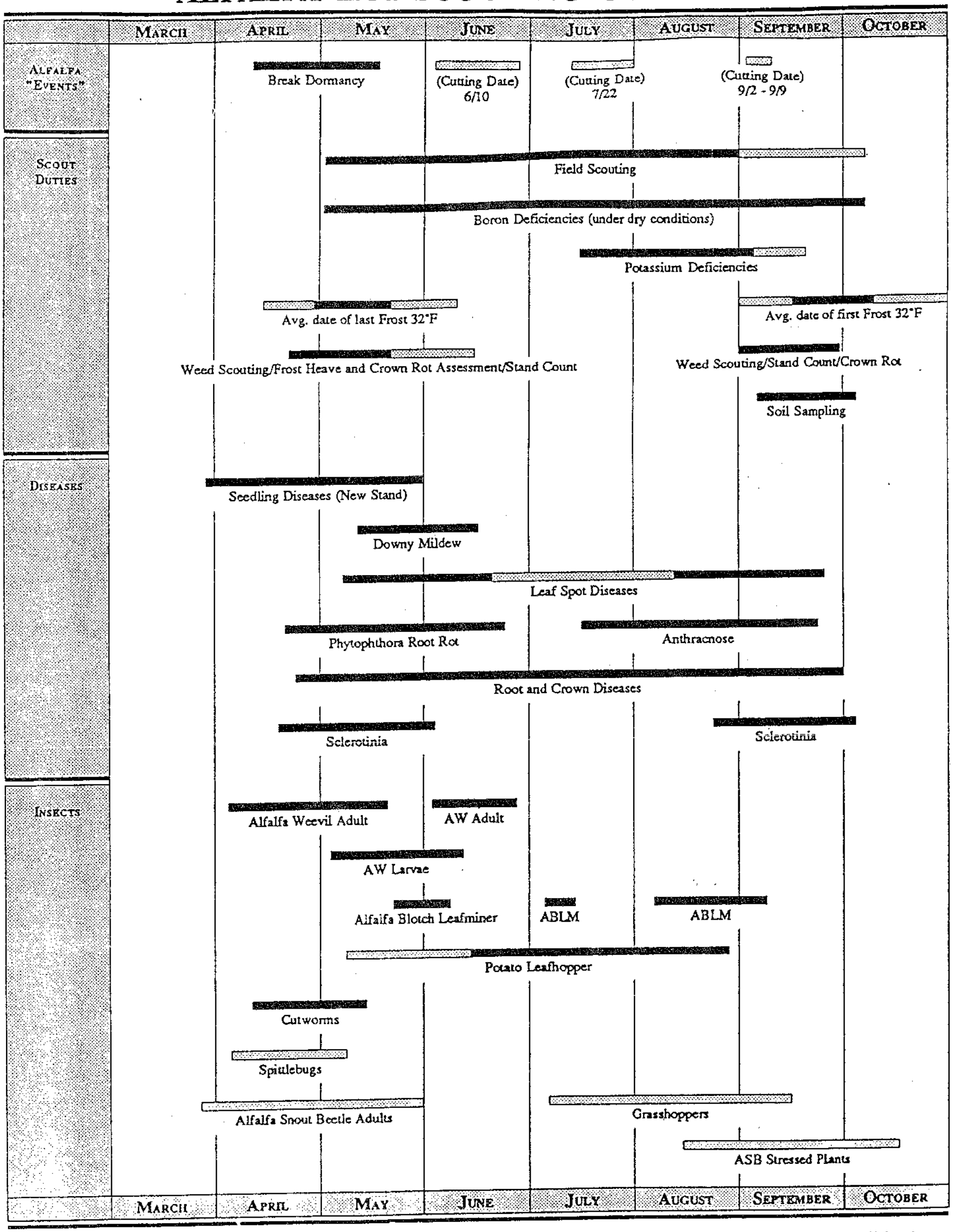
ALFALFA IPM SCOUTING CALENDAR



Developed by: J. K. Waldron, G. E. Bergstrom, E. J. Shields, R. R. Hahn, R. R. Seaney

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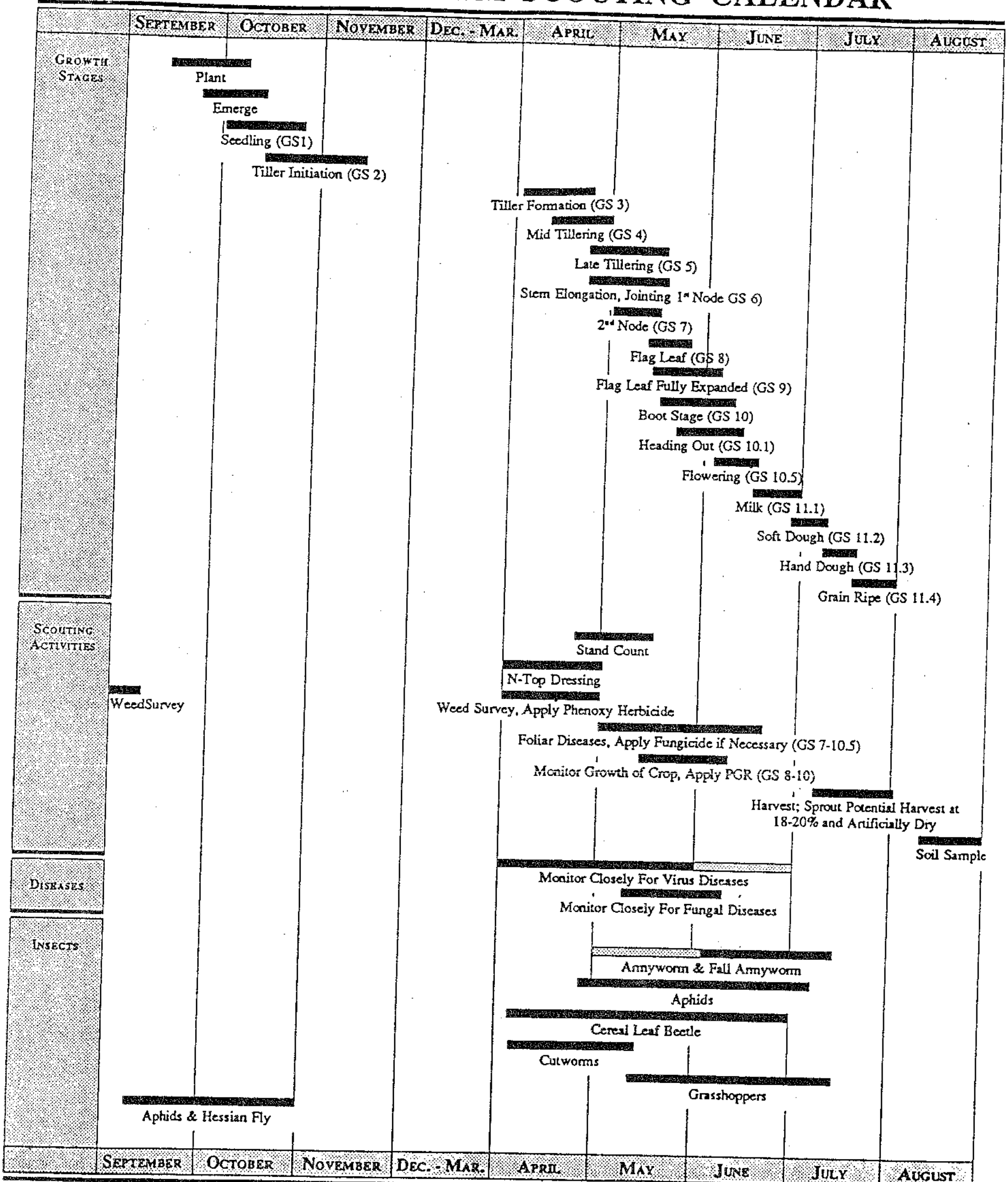
WINTER WHEAT IPM SCOUTING CALENDAR



Developed by: W. J. Cox, G. E. Bergstrom, J. K. Waldron, E. J. Shields, R. R. Hahn

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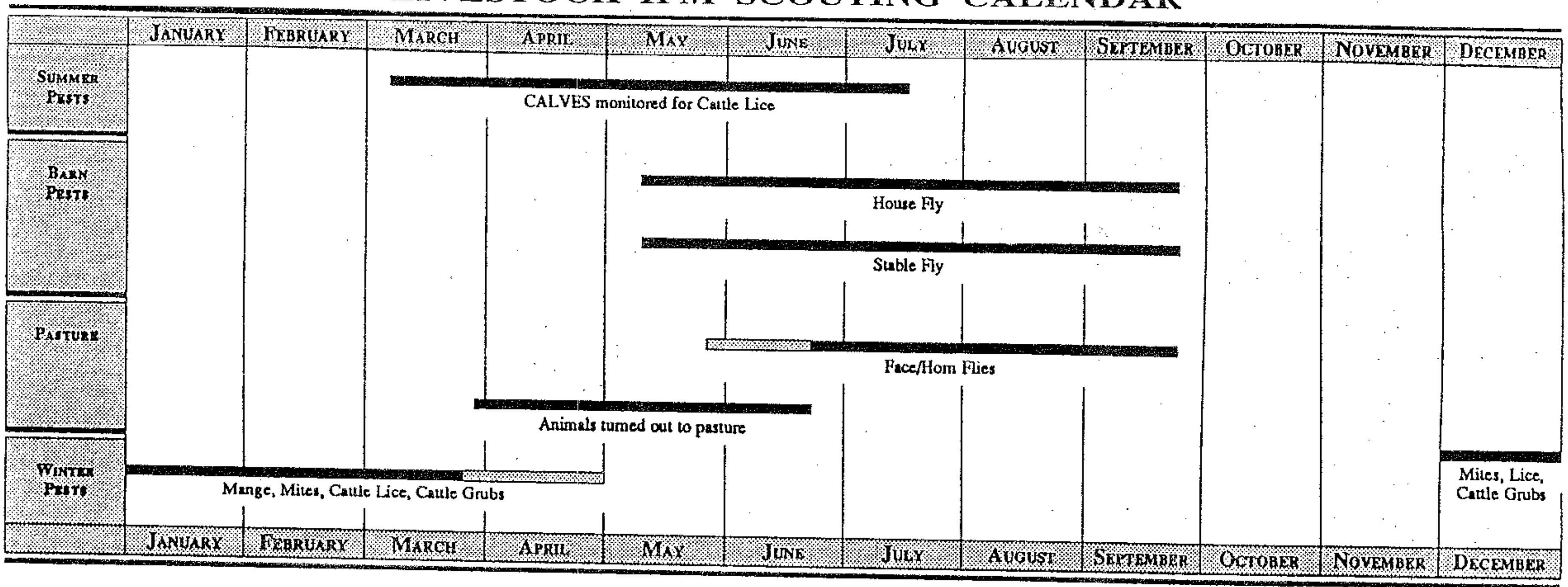
LIVESTOCK IPM SCOUTING CALENDAR



Developed by: D. A. Rutz, C. J. Geden, J. K. Waldron

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