LNE88-04

FINAL REPORT

"ACCELLERATING THE ADOPTION OF LOW INPUT SUSTAINABLE SYSTEMS FOR FIELD CROPS"

1988 - 1989 Low Input Sustainable Agriculture Grants Program

Western New York Crop Management Association
Cornell Cooperative Extension

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This project was made possible through grant funds received through the National Research and Extension Program on Low Input Sustainable Agriculture, appropriated by Congress in 1988 and administered regionally through the University of Vermont.

INTRODUCTION

The Western New York Crop Management Association is a grower-owned, non profit service cooperative, providing University recommendations in an intensive consulting program, designed to integrate all facets of best management systems for field crops. Initiated in 1986 as a Cooperative Extension educational program, the W.N.Y.C.M.A. grew from 12 initial farms to 120 farms at year end, 1989.

Growers enrolled in the W.N.Y.C.M.A. utilize management strategies focused on cost effective input selection and environmental responsibility. During the transition from extensive input use to intensive monitoring and selective chemical use, growers enrolled continually look for new avenues to increase input efficiency and reduce their dependence on chemical-based inputs.

The purpose of this project was twofold. First, interest among growers in non-conventional practices geared to input reduction is high. Practices like banding herbicides, soil conditioners, and companion seedings of cover crops have been well researched in the past, but have resurfaced due to the concern for soil and water quality. Additionally, these practices carry claims that a comparative advantage may result from effective implementation, relative to cost control and return on investment. Secondly, growers enrolled in the cooperative feel that the impact of using the ICM (Integrated Crop Management) concept on their farm has effectively led to greater profits, and felt that non-members could benefit from the public information generated through demonstrations which illustrate practices already in place.

The members of the Western New York Crop Management Association feel that the information they can provide to the Extension system in general will lead not only to greater utilization of the services their business can offer, but will increase the competitive position of growers across this region and New York State. Therefore, this project was co-sponsored by the local Cooperative Extension Associations and the W.N.Y.C.M.A. Two series of meetings were held by the cooperating parties to educate farmers on best management practices; introduce the project demonstrations and their objectives; and publicize further the program to increase the adoption of best management practices. Approximately 200 growers from across Western New York participated in the two meetings. A spring publication summarizing Low Input strategies applicable to Western New York was distributed to approximately 2500 farms in the region through Cooperative Extension in 1989.

The following project summaries document the objectives, procedures, findings, and recommendations for six selected demonstration projects. This publication is free of charge, and is provided by the Western New York Crop Management Association and Cornell Cooperative Extension as a public service to farmers across the northeast.

For additional copies, contact any Cooperative Extension office in Allegany, Cattaraugus, Chautauqua, Erie, or Wyoming Counties of New York, or John Deibel, Managing Consultant, W.N.Y. Crop Management Association, 21 South Grove St., East Aurora, NY 14052. Phone (716)655-4353.

PROJECT SUMMARY

"Evaluating the Response to Soil Insecticides for Corn Rootworm Control in Silage Production Systems"

Cooperator:

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Rich-A-Lu Farms
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Principle Investigators:

John R. Deibel, W.N.Y.C.M.A.
Dr. Elson Shields, Entomology, Cornell Univ.
Bruce Tillapaugh, Erie/Wyoming Coop. Extension

SITUATION:

Corn rootworm is a primary target pest for soil insecticides on farms in New York State. Scouting programs are developed to assess adult populations of rootworms the year prior to anticipated damage from the larval stage of the pest. The two principle strains of corn rootworm in New York are the Northern and the Western Corn Rootworm. Western rootworms have been increasing in New York, particularly Western New York, since 1981. This strain of rootworm is more aggressive and more damaging than the Northern strain. As a result of the steadily increasing proportion of Westerns to Northerns, scouting programs in Western New York are finding treatment levels of rootworm in stands which historically, did not reach an economic level.

The following table illustrates the percentage of fields reaching economic thresholds before and after 1986 in Western New York by production year in corn:

ESTIMATED PERCENTAGE OF CORN FIELDS REACHING ECONOMIC THRESHOLD FOR CORN ROOTWORM -- 1986 THROUGH 1989

Prod.Yr.	Pre - 1986	1986	1987	1988	1989
1st	10%	10%	21%	34%	20%
2nd	30%	30%	52%	73%	38%
3rd or more	50%	60%	70%	82%	69%

Notes:

1986 and pre-1986 estimates from observations by extension IPM programs
1987 - 1989 estimates are based on field scouting by the W.N.Y.C.M.A.

As a result of this continually increasing distribution of rootworm thresholds in first and second year corn during the late 1980's, growers have increased the use of soil insecticides. Since more than 70% of the corn utilized on C.M.A. farms is for silage in support of a dairy production system, growers are questioning the necessity of soil insecticide usage in silage vs. grain systems, particularly when adult numbers are not well above threshold the previous year.

OBJECTIVE:

-- To compare yields and quality of corn silage produced from treated versus untreated checks to assess the economic returns from t-banded insecticides.

DEMONSTRATION PROCEDURES:

Plot Dimensions:	660' X 45' (0.682 acres)
Treatments:	3 treatments X 3 replications = 9 treatments
	Full Rate (1.0 lb active) chlorpyrifos
	Half Rate (0.5 lb active) ""
	No Insecticide (check)
Fertilizer:	20-20-20 + 10,000 gal. liquid manure
Herbicide:	1 Qt. Atrazine + 1.5 Qt. Prowl, EPO
Variety:	Pioneer 3751
Planted:	May 19, 1989
Planter:	Kinze 2-row plot planter

OBSERVATIONS:

1. No observable differences in stand, root ratings, weeds, vigor, or other crop progress factors were noted throughout the scouting season between the treatments. Heavy rainfall during larval emergence may have reduced pressure.

2. Slight differences were noted at harvest time. Those differences were relative to goosenecking. A proportionately greater amount of goosenecking was observed as the rate of active ingredient decreased across the treatments.

YIELD SUMMARY:

1. Yields were taken using a portable mixer with electronic scales.
2. Composite samples were analyzed at D.H.I.C. Forage Testing Laboratory
3. Date harvested: September 28, 1989
4. Yields represent three replications of treatment against two replications of check.

YIELD SUMMARY -- SOIL INSECTICIDES ON CORN SILAGE

Rep.	Treatment	Wet Wt. (lbs)	%DM	Dry Wt. (lbs)	DM/Ac (tons)	35% Sil. (tons)
1	Half Rate	2280	36.1%	823.1	5.43	15.5
1	Full Rate	2170	37.0%	802.9	5.30	15.1
1	Check	2070	37.8%	782.5	5.16	14.8
2	Half Rate	2360	36.1%	852.0	5.62	16.1
2	Full Rate	2030	37.0%	751.1	4.96	14.2
2	Check	1950	37.8%	737.1	4.86	13.9
3	Half Rate	2120	36.1%	765.3	5.05	14.4
3	Full Rate	2250	37.0%	832.5	5.49	15.7
3	Check	2260	37.8%	854.3	5.62	16.1

CORN ROOTWORM INSECTICIDES ON SILAGE
FORAGE QUALITY ANALYSIS RESULTS BY TREATMENT

Treatment	Ave. Yield (35% DM) -tons-	C.P.* %	N.E.L.** (MCal/lb)	TDN*** %
Half Rate	15.3	6.6%	0.78	73
Full Rate	15.0	6.4%	0.76	72
Check	14.9	7.0%	0.78	73

* C.P. = Crude Protein
** N.E.L. = Net Energy for Lactation
*** TDN = Total Digestible Nutrients

CORN ROOTWORM INSECTICIDES ON SILAGE
ANALYSIS OF QUALITATIVE YIELD

Treatment	Ave. Yield Tons 35% Sil.	PER ACRE YIELDS BY QUALITY FACTOR: Tons Protein	Tons Energy
Half Rate	15.3	1.01	11.96
Full Rate	15.0	0.96	11.40
Check	14.9	1.04	11.62

ECONOMIC ANALYSIS:

ASSUMPTIONS:

1. -- Fertilizer costs (20-20-20) at $13.00 per acre
   -- Chemical costs at $18.00 per acre ($28.00 with insecticide)
   -- Seed costs at $25.00 per acre
   -- Fuel costs at $8.00 per acre
   -- Total fixed costs (land, machinery, labor, etc.) at $125/ac.
2. Use of insecticide caused no significant difference in quality
3. Rate of insecticide not relevant to yield.

CORN ROOTWORM INSECTICIDES ON SILAGE
ECONOMIC ANALYSIS

--BASED ON 35% DRY MATTER CORN SILAGE--

Treatment	Yield	---Costs per Acre---		---Costs per Ton---		
		Variable	Fixed	Variable	Fixed	Total
No Insecticide	14.9 tons	$ 74	$ 125	$4.97	$8.38	$13.35
Insecticide	15.2 tons	85	125	5.59	8.22	13.81
Difference	0.3 tons	$ 11	$ -0-	($0.62)	$ 0.16	($ .46)

SUMMARY AND CONCLUSIONS:

1. Since adequate pressure from CRW adults was found in the previous year, one must assume that environmental factors were present during larval emergence to reduce the level of feeding on the roots. Therefore, 1989 pressure may not have been adequate enough to provide more significant differences in the treatments. Response to a soil insecticide applied subsequent to prior year adult populations is contingent upon several environmental factors affecting the oviposition, emergence and potential feeding pressure from the insect. A multiple year analyses should be conducted for 3-5 years on this system to generate long-term findings and probability estimates.

2. Response to the use of an insecticide was variable through the three replications established. A significant difference in yield was found in 2 of the 3 replications established. Relative responses ranged from +2.17 tons of 35% corn silage, to -1.68 tons. Relative response was variable within each replication, but across the entire plot, amounted to 0.3 tons of 35% corn silage. Using only the assumed cost of the insecticide ($10.00 per acre), and not considering effect on fixed costs per ton produced due to increased yield, a response of 0.68 tons of 35% corn silage would have to be realized to offset the cost. Two of the six treatments resulted in a response greater than that amount.

3. Since corn rootworm migrates into a given field, different areas of a field will have varying levels of larvae emergence due to adult population concentrations in the field. This variability in larval activity could be observed through an equally variable level of goosenecking in the various treatments.

4. Since a degree of response to corn rootworm insecticides was found in this year's results, and assuming that larval pressure was reduced by saturated soils in June, one could conclude that in a more conducive year, a greater response may be generated by using soil insecticides.

5. Given the above cost assumptions, the use of a corn rootworm insecticide did not result in a reduction in costs per ton of corn silage produced, even though a physical yield response may have been generated. Economic returns could be

significantly affected by a shift in fixed costs, yields, or variable costs, and weather factors.

6. More research is needed to further examine whether the economic response generated in a corn for grain system is equal to, less than, or greater than a corn silage system. Furthermore, information is needed on what level of corn rootworm pressure can be withstood by a silage system vs. a grain system, if any.

7. Corn production systems must be managed under tight cost control. Therefore, any input costs which can be reduced or eliminated without suffering economic yield losses improves the returns over investment, results in more environmentally responsible practices, and less exposure to hazardous pesticides.

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PROJECT SUMMARY

Cooperator:

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Principle Investigators:

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Stuart Klausner, Agronomy, Cornell
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"A Comparison of Cornell Soil Test Recommendations to Alternative Rates and Subsequent Response in Alfalfa"

SITUATION:

Alfalfa production in Western New York is a pivotal component of a profitable crop/animal system. The costs of production relative to alfalfa are greater than any other perennial crop grown in this area due to the acid soils which predominate. Alfalfa must be produced on soils with near neutral pH in order to generate the greatest response to inputs and management.

One area of widespread controversy is fertility management of alfalfa. Several opinions are presented to farmers regarding how much, if any, additional fertilizer is needed on given field situations.

OBJECTIVES:

1. To compare the findings and interpretation of the fertility in identical soil samples as determined by the land grant laboratory (Cornell University Nutrient Analysis Laboratory) versus a private laboratory.

2. To demonstrate the Sufficiency Level of Added Nutrient (S.L.A.N.) concept used by Cornell's Soil Test Laboratory on alfalfa in a highly fertile soil situation, through comparison with alternative rates of Phosphorus and Potassium, for the duration of an alfalfa stand, across three comparable alfalfa varieties.

DEMONSTRATION PROCEDURES:

1. Site selected was seeded in the spring of 1988 to clear alfalfa.
2. Two soil samples were taken from the field to validate consistency.
3. Samples were split into two subsamples and sent to respective labs.
4. Treatment strips were established for three reps of five treatments.
5. The field was seeded to three varieties. Treatment design allowed for one entry in each variety.
6. Fertilizer was applied using a grain drill to ensure accuracy.
7. Fertilizer was applied after first cutting.
8. Boron and limestone is to be applied across entire field as needed.

FIELD INFORMATION AND HISTORY:

Field Size:	9.8 acres
Soil Type :	Chenango Gravelly Sandy Loam
Drainage :	Excellent
Crop History:	New seeding (1988); Corn Silage (1983-1988)
Seeding Method:	John Deere Drill
Fertilizer Used:	0-50-50 at seeding 0-40-160 in fall, 1988
Varieties:	Agway Excalibur DeKalb 120 Funks G-2352

SOIL TEST RESULTS

LABORATORY ANALYSIS RESULTS

SAMPLE	LABORATORY	pH	Phosphorus	Potassium	Magnesium	Calcium	C.E.C.	O.M.
1	Private Lab	6.1	174 ppm (VH)	251 ppm (VH)	106 ppm (M)	1020 ppm (M)	7.7	4.6%
	Cornell Lab	6.3	46 lb/ac(VH)	420 lb/ac(VH)	270 lb/ac(VH)	2740 lb/ac(MH)	---	4.0%
2	Private Lab	6.1	160 ppm (VH)	233 ppm (VH)	92 ppm (M)	960 ppm (M)	7.2	4.0%
	Cornell Lab	6.4	41 lb/ac(VH)	360 lb/ac(VH)	240 lb/ac(VH)	2670 lb/ac(MH)	---	4.0%

The above table illustrates that the identical subsamples tested very similarly in quantity and relative ratio of the macronutrients tested by each lab. Both labs appear to have judged the samples similarly in fertility level. pH extraction methods may be different between the labs, resulting in a slightly different pH reading.

LABORATORY RECOMMENDATION SUMMARIES

SAMPLE	LABORATORY	Lime	----Pounds per Acre Actual---- N	P	K
1	Private Lab	1.5	30	30	215
	Cornell Lab	1.5	0	0	0
2	Private Lab	1.5	30	30	215
	Cornell Lab	1.5	0	0	0

While no apparent difference exists in the lab's determination of relative fertility levels, there is clearly a difference in recommendations of N, P, and K for the field. Both labs recommended 1.5 tons of limestone per acre, even though the pH readings were slightly different, a function of extraction method and subsequent interpretation for lime needs.

TREATMENT DETERMINATION:

The purpose of this demonstration is to compare the Cornell Soil Testing Laboratory recommendation for N, P, and K, against increasing amounts of P and, to a greater extent, K, through the course of the rotation. Therefore, the recommended treatments were as follows for the demonstration:

#1 : 0 - 0 - 0
#2 : 0 - 30 - 0
#3 : 0 - 30 - 60
#4 : 0 - 30 -120
#5 : 0 - 30 -240

Boron and limestone are not being examined in this study. Therefore, those elements are to be applied annually across the entire plot as determined by the tests drawn over the course of the rotation.

OBSERVATIONS AND ACTIVITIES -- Year 1:

1. Harvest Dates (Year 1):

   June 7, 1989
   July 1, 1989
   August 30, 1989

2. Limestone was applied in spring, 1989.

3. Second crop yields were significantly affected by excessive moisture in June, causing slugs and alfalfa weevil to feed on emerging shoots. Due to low yields of second crop, representative areas were hand harvested because crop yield was not adequate for use of truck scales.

4. Potato Leafhopper reached economic threshold and was treated with an insecticide during third crop regrowth.

ECONOMIC ANALYSIS -- Year 1

Assumes:

Fixed Costs of $155.25 per acre, based on W.N.Y.C.M.A. averages of similar growing day area farms. (W.N.Y.C.M.A. Data Summary, 1987) Fixed costs include machinery ownership and repairs; Land Ownership or Rental; and Labor.

Direct Costs include: Seed (capitalized over 4 years); Lime (capitalized over 3 years); Fertilizer; Chemicals; and Fuel. Seed and Fuel calculated from C.M.A. farm data summary, 1987. Costs of N,P,K assumed at $.25,$.25 and $.15, respectively. Lime cost assumed at $25.00 per ton.

FERTILITY MANAGEMENT IN ALFALFA
YIELD SUMMARY AND ECONOMIC ANALYSIS - YEAR 1

Treatment	Plot Total Tons DM/Acre	Costs per Acre Direct	Costs per Acre Fixed	Costs per Ton of Dry Matter
0 - 0 - 0	3.2	$39.50	$155.25	$60.86
0 - 30 - 0	3.0	47.00	155.25	67.41
0 - 30 - 60	2.9	56.00	155.25	72.85
0 - 30 -120	2.9	65.00	155.25	75.95
0 - 30 -240	3.0	83.00	155.25	79.42

CONCLUSIONS:

1. The purpose of this demonstration is to apply varying rates of topdress fertilizer on a typical, highly fertile alfalfa field to examine changes in the economics of production for the course of a three year production cycle. Therefore, findings in the first year do not represent conclusive evidence of any kind. This report is provided to outline progress to date.

2. Additionally, the purpose of this study is not to compare the respective laboratory recommendations, specifically. Rather, the objective is to compare varying levels of added fertilizer to the untreated check, which represents the land grant recommendation.

3. Because of the high costs of alfalfa production, it is imperative that growers control inputs wherever possible. If an additional input does not realize a decreased cost per unit of production, i.e. does not generate a response in crop value exceeding the cost of the additional input, the additional input becomes a liability rather than an asset.

4. The addition of fertilizer at the rates specified did not generate an economic response in the first year of analysis.

5. The demonstration should be retained through the length of the rotation so as to analyze the treatments from year to year, and as a cumulative analysis at the end of the perennial crop's production.

6. Quality analyses should be run in the third and fourth years to evaluate changes in forage quality with varying rates of fertilizer application.

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PROJECT SUMMARY

"Utilizing Rye Cover Crops in Corn Systems"

Cooperator:

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Principle Investigators:

John R. Deibel, W.N.Y.C.M.A.
Bruce Tillapaugh, Coop. Extension

SITUATION:

Corn silage and grain are necessary components of a dairy/livestock production system in New York State. Home grown forages can be produced at sub-market values in this area. It has been well documented that corn produced in the first and second year of production consistently outyields third year and older fields. A primary reason for this difference lies in organic nitrogen provided by the decaying organic matter. Nitrogen budgeting in corn production systems is the cornerstone to effective nutrient management for the crop. Creating a soil environment which retains organic nitrogen in the plant available form, and in close proximity to the crop occupying the soil, is not only economically advantageous, but also prevents free nitrogen from entering the aquafer.

Additionally, row crops grown on sloping land create undesireable opportunities for relatively insoluble nutrients to flow off site through erosion. Phosphorus and Calcium applied for crop growth, from both organic and inorganic sources, are readily lost through erosion, entering ditches, streams, and surface waters.

Cover crops provide an acceptable means to accomplish several objectives. Properly established companion covers can retain free nitrogen during between crop periods when crop uptake would be negligible. Additionally, covers stabilize the soil surface and prevent erosion of soil and insoluble nutrients.

OBJECTIVES:

To evaluate three methods of establishing winter rye in corn silage systems.

1. Seeding the cover crop after harvest and harrowing in
2. Seeding the cover crop before cultivation
3. Seeding the cover crop after cultivation

DEMONSTRATION PROCEDURES:

During the summer of 1988, the cooperator established several different strips to compare the establishment means described above. In addition to winter rye, the grower also established strips of spring oats and red clover, to evaluate the success of each.

Sites were selected to compare the seeding methods and the subsequent yield of rye. The rye was harvested (tops and roots) in the spring of 1989. Dry Matter conversions were made of the yields. Soil tests were taken on the "before cultivation" sites to assess soil nitrate levels against the "after harvest" treatment and an untreated check.

RESULTS:

The following table illustrates the comparison of yield from rye established before cultivation vs. after cultivation vs. after harvest:

YIELDS OF RYE COVER CROPS SEEDED AFTER HARVEST VS. AT CULTIVATION TIME

Harvested April 20, 1989

Site	Description	Dry Matter Yield per Acre
1	Post Harvest	2723 lbs.
1	Before Cultivation	4764 lbs.
	Difference	2041 lbs.
2	Post Harvest	2994 lbs.
2	After Cultivation	4084 lbs.
	Difference	1090 lbs.

SOIL NITRATE TEST RESULTS

Treatment	Soil Test Nitrate
Check (no cover)	18 lbs/acre
After Harvest	20 lbs/acre
Before Cultivation	21 lbs/acre

Soil tests were taken at 12" depth and immediately dried to increase the reli- bility of the nitrate test.

Crop height was 10" when tests were taken.

FINDINGS:

1. Winter rye cover crops can provide a means for retaining free nitrogen in the soil. Comparison of the nitrate levels found illustrate that with the presence of a rye cover crop resulted in a slight increase in nitrate levels at 10" corn height the following year.

2. Establishment of winter rye is best accomplished at 8-16" corn height, at cultivation time. Comparison of before cultivation establishment and after harvest establishment yielded 75% more cover. Comparison of after cultivation vs. after harvest yielded an increase of 36% more rye. Before cultivation yielded an additional difference of 951 lbs. per acre, or an 87% increase over the comparative advantage found in the after cultivation plot.

3. Clover plots were not successful when seeded before cultivation, probably due to the cultivator burying the seed. Spring oat covers seeded at cultivation established well, but did not result in significant cover because they elongated, headed, and senesced prior to harvest.

RECOMMENDATIONS:

As a result of this demonstration, the following recommendations can be made:

1. Establishing winter grain cover crops is best accomplished ahead of the cultivator.

2. Small seeded legumes should be established in the same manner as field seedings. In order to accomplish this, one should use an in-row grain drill with drop tubes and a press wheel to pack the seed.

3. Spring oats, established to cover the soil and shade winter annual weeds prior to minimum or no-till seedings the following spring are best introduced in the fall, immediately after harvest of corn silage so as to prevent volunteer grain encroachment; and provide adequate cover in the fall.

4. More research is needed to assess the nutrient contributions of cover crops for the subsequent crop to be grown. Additionally, comparisons of many different legumes, grasses, and small grains need to be developed. As part of 1989 funding of the L.I.S.A. program, Dr. Jane Mt. Pleasant is conducting research at several locations across New York to accomplish this.

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PROJECT SUMMARY

"The Economics of Banding Herbicides in Corn"

Cooperator:

David Cobo
West Valley, NY

Principle Investigators:

David DeGolyer, WNYCMA
John Deibel, WNYCMA

SITUATION:

During the early adoption period of herbicide use, a common method for applying preemergence materials was through the use of band applicators, providing in-row activity, while physical weed control was provided through cultivation of the mid-row area. As herbicide technology expanded, and the relative cost/benefit from its use favored field-wide spraying, the practice of banding became practically obsolete, as did row crop cultivation.

Over the past five years, row crop cultivation has returned at a significant rate. In 1983, growers participation in scouting programs who used row crop cultivation numbered 1 out of 12 farms, or 8.3%. During 1988, 44 of the 110 farms served by the WNYCMA used cultivation on at least a portion of their corn crop, a 32% increase in five years. Several developments have led to a resurgence in the use of row crop cultivation. They include:

-- better air/water relations, decreasing surface compaction, and increasing root penetration.
-- control of annual grass weeds escaping preemergence herbicides due to weather factors or selection.
-- suppression of certain simple and other perennial weeds over time.
-- increased use of sidedressing rather than applying nitrogen preplant, offering an opportunity to combine the operations.

Several farmers have questioned whether certain herbicide practices could be adjusted to reduce the costs of materials, while maintaining yield potential. This may involve changing families of herbicides when cultivation is used, an example being reducing the rate or use altogether of acetanalide materials (Dual, Lasso) which are used for annual grass control, and substituting with the cultivator; or using the same combinations as before, but banding the treatment to reduce the total amount applied.

OBJECTIVE:

To demonstrate the best management practices necessary to successfully implement a banded herbicide program, and to analyze the comparative costs of the practice when compared to conventional means.

MATERIALS AND METHODS:

Herbicides were applied on the planter. Banded treatments were applied using 008 even-flow flat fan nozzles set for a 12" band. A cultivator was used twice, first at the 4 leaf-stage (corn)(June 1st), the second, at layby (12").

BANDING HERBICIDES IN CORN -- 1989
DEMONSTRATION SUMMARY AND COST ANALYSIS

FIELD INFORMATION:

ACRES	:	13.2
PRODUCTION YEAR:		5th
SOIL TYPE	:	Chenango Silt Loam
DRAINAGE	:	Excellent

SOIL TEST RESULTS:

Year Tested :	1989		
pH:	6.6		
Phos:	7	lbs/ac	(med-high)
Potash:	280	lbs/ac	(very high)
Magnesium:	305	lbs/ac	(med-high)
Calcium:	2800	lbs/ac	(med-high)
Org. Matter:	5.0	%	(high)
Zinc:	0.9	lbs/ac	(med)

ITEM	---Costs per Acre--- Conv.	Banded	Diff.
Seed	$22.00	$22.00	
Chemicals	$33.62	$17.49	($16.13)
Limestone	$10.00	$10.00	
Fertilizer	$51.60	$51.60	
Fuel:			
Tillage	$3.15	$3.15	
Planting	$0.45	$0.45	
Cultivating	$0.44	$0.88	$0.44
Harvesting	$1.04	$1.04	
Labor	$30.00	$32.80	$2.80
TOTAL DIR.:	$152.30	$139.41	($12.89)
Mchnry.Own.	$54.00	$57.00	$3.00
Mchnry.Rep.	$33.00	$33.50	$0.50
Land	$35.00	$35.00	
TOTAL FXD.:	$122.00	$125.50	$3.50
TOTAL ALL :	$273.86	$258.08	($9.39)
YIELD :	130.8	130.8	--
COST/BU. :	**$2.09**	**$1.97**	**($0.12)**

HISTORICAL WEEDS:

Annual Grasses (slight)
Horsenettle (slight - moderate)
Nutsedge (moderate)

FERTILIZER USED:

Manure	:	20 tons/acre
Preplant	:	0 - 0 - 60
At Planting:		25 - 50 - 50
Sidedress	:	80 - 0 - 0

CHEMICALS USE

Atrazine	1.0 pt./ac.
Bladex	2.0 qt./ac.
Dual	2.5 pt./ac.
Thimet	5.0 lb./ac.

NOTES TO ECONOMIC ANALYSIS:

1. Cost of setting up planter and owning cultivator at $2000
2. Cultivation consumes 0.2 hrs/ac.
3. Fuel costs: Planting: 0.7 gal/ac; Cultivating: 0.49 gal/ac; Har Tillage: 3.5 gal/ac.
4. All spraying operations completed on the planter.
5. Input costs:

Nitrogen :	$0.22 per actual pound	Atrazine:	$1.14 per pint
Phosphorus:	$0.24 per actual pound	Bladex :	$2.55 per pint
Potassium :	$0.15 per actual pound	Dual :	$6.35 per pint
Limestone :	$30.00 per ton	Thimet :	$1.28 per pound
Fuel :	$0.90 per gal		
Labor :	$7.00 per hour		

CONCLUSIONS:

1. Banding herbicides requires additional labor at a crucial time during the season.

2. In this analysis, banding of herbicides saved a total of $12.89 in direct (annual) costs per acre, but amounted to an increase of $3.50 per acre in fixed costs due to machinery conversions and ownership. After considering all the costs associated with the practice, the resulting net savings is estimated at $9.39 per acre. After applying these costs to yields, the banding program corn production costs of $1.97 per 14.5% adjusted bushel vs. $2.09 per bushel for the conventional program, a difference of $.12 per bushel, or a 6% decrease in costs.

3. Therefore, if a grower has access to the necessary labor and machinery to successfully implement a banded herbicide program, it is possible to reach yield potential while lowering input costs and using less chemical herbicide inputs in corn.

GUIDELINES FOR BANDING HERBICIDES IN CORN:

1. A grower should initiate the practice on no more than 10% of their corn acreage in the first year.

2. The site selected should have a relatively clean weed history. Fields NOT to initiate the practice on include sod fields, heavily manured fields, and fields with persistent weed escapes.

3. The first cultivation must be accomplished early. It is the MOST critical phase of the practice. Weeds should be no larger than 2 leaves. A rotary hoe cultivator or a cultivator with shields should be used.

4. With the absence of herbicide residue in the row, one might consider introducing a cover crop at cultivation time to possibly suppress late grasses, retain free nutrients after harvest, and prevent erosion.

PROJECT SUMMARY

"Managing Clear Grass Stands vs. Short Term Legume Mixtures on Highly Erodible Fields"

Principle Investigator: John Deibel, W.N.Y.C.M.A.

SITUATION:

Perennial forage production is a critical component to profitability on dairy and livestock operations in Western New York. The crop enterprise must be operated at peak efficiency, with costs controlled and yields maximized, in order to justify its management.

It has been well established that the grower must maximize the soil resource. Attempting to produce legumes on down drainage sites over the long term often results in loss of the stand and a reduction in profitability. The following shows the relative costs of production per ton of dry matter by percent legume in the stand:

RELATIVE COSTS PER TON OF DRY MATTER BY PERCENT LEGUME
W.N.Y.C.M.A. CROP RECORDS DATABASE SUMMARY -- 1987
3877 ACRES -- GRASS AND MIXED HAY

PERCENT LEGUME IN STAND	AVE.TONS DM/ACRE	AVE.COSTS PER ACRE	AVE.COSTS PER TON DM	AVE.COSTS PER TON (85% DRY HAY)
0%	2.5	$131.65	$ 52.66	$ 61.95
25%	3.4	$172.57	$ 50.76	$ 59.71
50%	3.5	$198.28	$ 56.65	$ 66.64
75%	3.7	$236.58	$ 63.94	$ 75.22

The relative costs per acre rise directly with the percent legume managed in the stand. As production level rises, so do the costs associated with production. Quality increases increase the value of the production. It is imperative that with the increasing costs of legume production, the crop reaches yield potential to keep costs per unit low.

THINGS TO CONSIDER:

A. Longevity:

The relative value of perennial legume crops decreases with stand life due to disease and harvesting frequency. On down drainage sites, the survivability of legumes is significantly decreased.

If slope is restrictive, the grower is forced to leave the field in a sod for longer periods of time.

Three options exist for poorly drained fields:

1. Plant a mixture of alfalfa, trefoil, clover, and/or grass and maintain the stand as long as possible.

2. Plant clover with a grass and maintain the legume for 2 years, then manage the grass alone.

3. Plant grass alone then manage as such for the rotation.

When both poor drainage and restrictive slope are present, the options become more restrictive. Sods on such sites should be seeded down for 5 years or more. When short lived legumes seeded with lowered rates of grass, the fields often are left with low populations of grasses due to the initial seeding rate and abusive 3 or 4-cut systems, and in 4-5 years, the stand is unproductive with absence-presence weeds encroaching in the stand, further lowering quality and yield.

B. Manure Management:

The majority of dairy/livestock farms in Western New York apply manure in a daily spread system. This system becomes challenging in mid summer, when there is no open ground for application. Alfalfa stands should not receive heavy rates of manure during the season. The following estimates the total manure produced on a farm raising 100 cows and 50 heifers:

Estimated Manure Produced from 100 Cows and 50 Heifers

No. Cows	Ave.Wt.	No. Heifers	Ave.Wt.	Total Manure Produced Annually
100	1200 lbs.	50	800 lbs	2400 tons

-- Based on 15 tons/1000 lbs. of animal unit per year. (Source: Cornell Field Crops Handbook, 1978)

Manure is often over applied on corn ground, many times averaging over 30 tons/acre. Nitrogen requirements for corn are usually met at manure levels of 20 tons/acre, and often less than that. As a result of this over application, nutrient levels on manured corn ground become excessive.

Growers are looking for ways to better allocate their on-farm manure. Clear grasses are a viable option.

C. Animal Nutrition Concerns:

Dairy nutritionists have expressed concern over the lack of digestible fiber in the ration of high producing cows, as well as dry cows and heifers. In order to maximize the more concentrated nutrients contained in ingredients and high protein forages, the cow must receive adequate rations of clean fiber to keep the digestive system operative. Since well managed grasses contain desireable levels of Neutral Detergent Fiber (NDF), many dairymen have been advised to increase the frequency and/or amounts of these feeds in the diet.

OBJECTIVE:

Analyze the principle mixtures of legumes and grasses on poorly drained soils, over the course of a rotation, and over three production years, comparing yields and costs of production, using WNYCMA database records.

ANALYSIS:

379 fields of perennial hay crops were selected from the database. Fields consist of those with drainage ratings of poorly and somewhat poorly drained soils. Four mixtures of species were examined. Only fields in their 2nd year and above were selected, avoiding seeding year analyses. The abbreviations and primary description of each follows:

Species Selected:

ABT - Alfalfa-Birdsfoot Trefoil-Grass: Recommended for variably drained sites containing areas not suited to alfalfa. Typical cutting management: 2 cuts (seeding year); 3 cuts (year 2 and beyond). Seeding rate: alfalfa (6 lbs/ac); trefoil (4 lbs/ac); grass (6 lbs/ac). pH requirement: 7.0

AGT - Alfalfa-Grass: Recommended for well drained sites. Typical cutting management: 2 cuts (seeding year); 3-4 cuts (year 2 and beyond). Seeding rate: alfalfa (8-12 lbs/ac) plus timothy (4-6 lbs./ac), bromegrass (5-8 lb/ac) or orchardgrass (4-6 lb/ac).pH requirement: 7.0

CGT - Clover-Grass: Recommended for poorly drained sites for short term hay, 2-3 years. Seeding rates: Clover (6-8 lbs/ac) plus timothy (6 lbs/ac). pH requirement: 6.2.

GRT - Clear Grass: Recommended for long term grass production. Typically cut 1 time seeding year, and 2 cuts in each following year. Seeding rates: Timothy (8 lbs) or Bromegrass (15 lbs) or Orhardgrass (10 lbs) or Reed Canarygrass (8-10 lbs). pH requirement: 6.0-6.2.

NUMBER OF FIELDS SELECTED
W.N.Y.C.M.A. CROP RECORDS DATABASE
1986 - 1988

	--------SPECIES MIXTURE------				
PRODYR	ABT	AGT	CGT	GRT	ALL
2	36	29	25	8	98
3	18	46	36	11	111
4+	34	56	17	63	170
ALL	88	131	78	82	379

Costs of Production:

The cost of forage production can be broken down into two categories, fixed and direct. In this analysis, fixed costs represent a value assigned to factors which don't generally change from year to year. They include land ownership, land improvement, buildings, machinery ownership and repair, and labor. Machinery ownership is assigned according to the depreciable value for a given year plus a 10% interest charge, calculated against the acres, production, and relative percentage of use for hay, corn, and small grains. Machinery costs are charged against only the portion used for crop production. Buildings considered are only those used to maintain crop equipment and shops. No charge is assigned to permanent crop storage facilities, but temporary facilities are considered in the analysis. Land costs are charged as a return on investment, calculated from real property value. Direct costs include seed, fertilizer, chemicals, custom, fuel, and a capitalized charge for limestone, assigning 1/3 of the lime investment over each of three years following application.

As a result of this categorization, fixed costs are a significant contributor to crop profit. Unless yield potential is achieved, fixed costs must be absorbed by a lower yielding crop and profits are affected. The return on fixed cost investment should be a primary consideration in crop profit analysis.

The following table illustrates the relative contributions to fixed versus annual costs of production for those fields listed at the beginning of this project summary (page 18):

RELATIVE COSTS PER TON OF DRY MATTER BY PERCENT LEGUME
W.N.Y.C.M.A. CROP RECORDS DATABASE SUMMARY -- 1987
3877 ACRES -- GRASS AND MIXED HAY

PERCENT LEGUME IN STAND	TOT.COSTS PER ACRE	FIXED COSTS PER ACRE	DIRECT COSTS PER ACRE
0%	$131.65	$117.17	$ 14.48
25%	$172.57	$128.00	$ 44.57
50%	$198.28	$139.83	$ 58.45
75%	$236.58	$138.10	$ 98.48

As the percent legume rises, direct costs per acre also increase. More cuttings per year, higher production per acre, and higher input requirements all contribute to this increase. Therefore, the grower must offset this increase with increased yield and quality in higher legume stands.

The following table shows the average dry matter yield for each species mixture in the subset analysis:

W.N.Y.C.M.A. CROP RECORDS DATABASE
1986 - 1988
DRY MATTER YIELDS

	-----SPECIES	MIXTURE-----			
PRODYR	ABT	AGT	CGT	GRT	ALL
2	3.0	4.0	3.0	2.2	3.0
3	2.7	3.1	2.6	2.2	2.8
4+	2.7	2.4	2.2	2.1	2.4
ALL	2.8	2.9	2.6	2.1	2.6

One consideration that must be kept in mind is that prior to 1987, very few grass fields in this analysis were actually seeded to clear mixtures. The majority were seeded to grass-legume mixtures, and are now managed as clear grass meadows. Therefore, the yields in years 4 and beyond may be less than if the stands were managed for clear grass from seeding year.

As can be seen in the previous table, yields of alfalfa stands decreased significantly after the second year. This illustrates the necessity to establish species of perennial forages that will persist in a given site over time. When considering the total costs associated with the different mixtures, it becomes difficult to produce crops at a profit when yields decrease as they do.

When equating the total costs on a per unit of production basis, the following was found:

W.N.Y.C.M.A. CROP RECORDS DATABASE
1986 - 1988
COST PER TON OF DRY MATTER

	----------SPECIES	MIXTURE------------			
PRODYR	ABT	AGT	CGT	GRT	ALL
2	$54.34	$46.12	$34.76	$56.41	$53.37
3	$53.08	$56.00	$51.48	$58.63	$55.30
4+	$50.99	$62.78	$53.24	$59.87	$55.71
ALL	$53.17	$55.23	$52.19	$60.04	$55.21

Note the significant increase in costs per ton of dry matter on fields seeded to alfalfa or clover. The significant loss in production accounts for such a dramatic increase in costs per ton produced. Note that the clear grass fields and the alfalfa/birdsfoot fields stayed relatively constant in the costs per unit produced through the rotation.

CONCLUSIONS:

1. Fields suited to alfalfa production can yield significant profits through yield and quality of the forage produced. However, poorly drained sites must be managed to produce the most crop at the lowest expense.

2. Managing short lived legumes in poorly drained soils is generally not productive. Since the peak years of profitability are the second and third years, it is important to maintain stand population and vigor. Soils not suited to legume production may be better off seeded to a clear grass at appropriate seeding rates.

3. More intensive management of grass stands may be necessary. If a legume component is not present, the grower must provide nitrogen to the crop. This is accomplished in one of two ways:

- apply chemical nitrogen at the optimum time for utilization. The greatest response to chemical nitrogen application is in the early spring, as soon as the grass breaks dormancy. A second application of nitrogen may provide a response after first cutting if rainfall is above normal at the time of application and soon afterwards.

- apply organic nitrogen through regular applications of on-farm manures, applied in the summer, fall, or spring prior to crop need. Since the manure is applied on the surface of the soil, the ammonia portion of the resource is lost to volatilization. The organic fraction, however, will be leached into the root zone, and under proper environmental conditions, taken up by the plant. Annual applications of manure nitrogen helps to maintain proper levels for crop growth. Since the grass actively is taking up nitrogen, the amount of free nitrate nitrogen is retained by the crop system, and not moved off site through leaching or other means.

4. Cutting management of grasses should be emphasised. A three-cut system may be harmful to grass stands, particularly during the first few years after establishment, and especially the timing of first cut. The cool season grass should be allowed to boot and head in order to optimize longevity. Many grasses are lost in legume mixtures cut three to four times annually.

5. Species and rotation practices should be decided based on anticipated longevity of the species planted. Once the principle species runs out, weed encroachment and low stand populations contribute to a significant loss in production. Good rotational planning is essential to profitability.

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PROJECT SUMMARY

"Response to Selected Soil Conditioning Products in Differing Corn Silage Systems"

Cooperators:

Ray and Larry Hill, Cattaraugus, NY
Frank Walker and Sons, Falconer, NY

Principle Investigators:

John Deibel, WNYCMA
David DeGolyer, WNYCMA
Lydia Cunningham, WNYCMA
Dale Dewing, Agronomy Agent

SITUATION:

In recent years, products have been marketed with claims that significant changes in the soil's ability to utilize nutrients may occur from their use. These products, termed "soil conditioners" are designed for different purposes. Most conditioners are designed to either improve soil/water relations through aiding the water movement process (wetting agents), or claim to increase the amount of plant available nutrients tied up in the organic and mineral complexes of the soil through microbial activators or enzymatic action.

Using wetting agents in hydrophobic soils may have potential benefits. However, in the soils managed for field crops in Western New York, an increasing number of claims are made that use of a microbial activator or enzyme based conditioner can allow a grower to reduce the amount of fertilizer nitrogen applied due to the increase in available nitrogen and other nutrients provided through the use of the conditioner product.

The purpose of this project is to establish two field demonstrations to determine if significant changes in yield result; to document the costs associated with their usage; and to analyze the resulting economics of production.

PROCEDURES:

Two sites were found on which to establish field size plots. One field has been continuously row cropped for several years, with no manure applied. The other is a second year stand, where 20 tons or more manure was applied since rotating to corn. Two products were selected.

NITROMAX: claims to improve photosynthesis, and reduce the rate of nitrogen required for crop production. A two step process is involved, using three products:

1. Nitromax Soil Supplement
2. Agri-Products Soil Conditioner
3. Agri-Products Guardian Adjuvant:

Treatment Protocol:

1. Treat seed prior to planting with a mixture of the above products.
2. Foliar feed the crop at 8-12" of height with the material.

BIOTILL: claims to increase the available nutrients contained in soil organic and mineral complexes.

Claimed Activity:

Increases microbial activity in the soil, plant available nutrient availability is increased.

Protocol:

Apply after planting prior to rainfall.

DEMONSTRATION PROCEDURES:

Strip demonstrations were established on two separate sites. A description of each follows:

<u>Site #1</u>: Ray and Larry Hill, Cattaraugus, NY

Crop: Corn Silage (3rd year following continuous snap beans)
Soil: Chenango Gravelly Silt Loam -- well drained
Hybrid: Halsey 3593 (95 day)
Date Planted: May 27th

Soil Test Information:

Year Tested: 1988
Lab: Cornell

pH : 5.1
Phos : High
Potash: High
Mg : Med
Ca : Low-Med

Limestone: 3 tons/acre incorporated
Herbicide: 2.0 qt. Bladex + 2.5 pt. Dual + 1.0 pt. Atrazine (ppi)
Insecticide: None
Starter : 17-34-17
Treatments :

1. No Conditioner vs. Biotill vs. Nitromax
2. Starter vs. No Starter
3. Nitrogen Treatments:

60 lbs. PPI + 90 lbs. SD
120 lbs. PPI + 90 lbs. SD
120 lbs. PPI + 0 lbs. SD
0 lbs. PPI + 90 lbs. SD
0 lbs. PPI + 0 lbs. SD (untreated check)

Site #2: Frank Walker and Sons, Falconer, NY

Crop: Corn Silage (2nd year following alfalfa sod)
Soil: Chenango Gravelly Silt Loam -- well drained
Hybrid: Unknown
Date Planted: May 10th

Soil Test Information:

Year Tested: 1988 Lab: Cornell

pH : 6.8
Phos : High
Potash: High
Mg : Med-High
Ca : Low

Herbicide : 2.0 qt. Bladex + 2.5 pt. Dual + 1.0 pt. Atrazine (ppi)
Insecticide: None
Starter : 10-20-10
Manure : 20 tons/acre fall applied
Treatments :

1. No Conditioner vs. Biotill vs. Nitromax
2. Starter vs. No Starter

OBSERVATIONS:

1. Scouting reports during the season showed no significant, observable differences between the treatments at either site.

2. Site #1 (continuous row crop) was erroneously sidedressed where such treatment was not called for. Therefore, no reliable data relevant to sidedress response was attainable.

3. Site #2 (manured, rotated) was affected by turkey and coon rodents.

4. Both sites were assessed by observation at dent stage to determine the nitrogen status of the plants in each treatment. In site #2 (manured), no nitrogen deficiencies were observed. In site #1, nitrogen deficiencies followed the rate of nitrogen applied. In neither site did the soil conditioners exhibit a beneficial response in plant appearance.

CONCLUSIONS:

1. In the sites used for this analysis, it appears as though soil conditioners do not provide a consistently significant yield response. Yields of both sites showed wide variations in response, from -0.3 tons to +8.7 tons of 35% dry matter silage on a per acre basis, compared to the untreated checks.

2. When considering the cost of the material ($12-$14/acre) and the cost of the extra trips across the field ($5-$7/acre), the following economic analyses were found:

PARTIAL BUDGET ANALYSIS -- SOIL CONDITIONERS ON CORN FOR SILAGE CONTINUOUS ROW CROP -- NO MANURE -- LOW pH

	None	Biotill	Nitromax
SEED	$25	$25	$25
FERTILIZER	$38	$38	$38
CHEMICALS	$19	$19	$19
CONDITIONER	$ 0	$13	$13
LIMESTONE	$28	$28	$28
FUEL	$ 8	$10	$12
LABOR	$30	$32	$33
TOTAL DIRECT COSTS	$148	$165	$168
ESTIMATED FIXED COSTS	$171	$171	$171
TOTAL COSTS PER ACRE	$319	$336	$339
BREAK EVEN YIELD (TONS SILAGE) (assumes $14.50/ton value)	22.0	23.2	23.4
PLOT AVERAGES (YIELD)	14.8	15.5	13.1
PLOT COST PER TON AS HARVESTED	$21.55	$21.60	$25.87

PARTIAL BUDGET ANALYSIS -- SOIL CONDITIONERS ON CORN FOR SILAGE SECOND YEAR FOLLOWING ALFALFA SOD -- HEAVY MANURE

	None	Biotill	Nitromax
SEED	$25	$25	$25
FERTILIZER	$ 9	$ 9	$ 9
CHEMICALS	$19	$19	$19
CONDITIONER	$ 0	$13	$13
LIMESTONE	$ 0	$ 0	$ 0
FUEL	$ 8	$10	$12
LABOR	$30	$32	$33
TOTAL DIRECT COSTS	$91	$108	$111
ESTIMATED FIXED COSTS	$171	$171	$171
TOTAL COSTS PER ACRE	$262	$279	$282
BREAK EVEN YIELD (TONS SILAGE) (assumes $14.50/ton value)	18.0	19.2	19.4
PLOT AVERAGES (YIELD)	13.9	14.1	12.3
PLOT COST PER TON AS HARVESTED	$18.84	$19.78	$22.92

NOTES TO COST ANALYSIS:

Costs per acre were calculated using product averages. Additional labor charges were approximated at $2.00 per acre for the one-pass Biotill treatment, and $3.00 per acre for the spraying pass and the additional time used to treat the seed for the Nitromax treatment.

CONCLUSIONS:

1. These trials represent one growing season's results. Neither plot was designed for replicated, response estimation, but rather, to demonstrate the costs and activities involved in using these products. Yields were generally poor in the region during this season due to untimely, excessive rain early, and prolonged drought in mid-season. In order to accomplish a reliable response analysis, the products should be tested in a small plot, replicated over a number of growing seasons.

2. Neither product performed significantly better, nor worse than the other product, or against the untreated areas. However, claims by the manufacturers state that multiple year use may be needed before significant changes can be seen.

3. More research is needed in a replicated plot design to test the materials at varying fertilizer rates and a check. In order to properly accomplish this, the plots should be set up in a small plot design with benchmark and after treatment soil tests.

4. The costs of corn production and the cash flow required to maintain the crop enterprise leave little room for error. Yield potential must be met through a balanced program which includes efficient input use, timely field operations, and optimized harvest and storage.

5. If considering the use of soil conditioners, the grower should first conduct a controlled study on selected fields first. Suggestions on plot layout and assessment methods are available from your county extension agent, C.M.A. technician, industry representative, or private consultant.

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SUMMARY

This publication summarizes six projects conducted during 1988 and 1989 by the Western New York Crop Management Association Cooperative in conjunction with selected extension and college staff from Cornell Cooperative Extension. The objective of the project was to demonstrate some of the practices in place on C.M.A. farms, geared to more efficient production of field crops, while additionally demonstrating more responsible input management.

The Low Input Sustainable Agriculture Program is a federally funded grants program to individuals, groups, companies, and institutions interested in furthering the use of environmentally responsible input use in Agriculture. The L.I.S.A. initiative does not necessarily indicate that with lowered input, the grower must lower their profit margin. The practices promoted through L.I.S.A. programs across the country are fundamentally geared to utilize the natural resources available to the farmer in a manner that will conserve those resources, while producing a crop at profit. Growers must continue to control costs through efficient input purchasing. Through an intensive program of information management...in the field and in the farm office, the grower can be more proactive in the decisions they make relative to purchased inputs. Programs such as those offered by Crop Management Associations, Private Consultants, and other groups can assist the grower in making sound management decisions.

The directors, members, and staff of the Western New York Crop Management Association would like to express their thanks to the Northeast Regional L.I.S.A. Committee, Cornell University, and Cooperative Extension for the opportunity to participate in this program. It is our hope that as a result of this and future projects, farmers everywhere can benefit from the work put forth to further the use of land grand recommendations on American farms. It is this basis on which agriculture has become what it is today in America, and it will be this system that ensures its continued health.

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