What's Cropping Up?

A NEWSLETTER FOR NEW YORK FIELD CROPS & SOILS VOLUME 3, NUMBER 5, 1993

II. Mapping Pesticide Leaching Potential at Landscape Scale

Steve DeGloria
Soil, Crop and Atmospheric Sciences

There is an increasing use of computer simulation models to predict the fate and transport of chemicals in agricultural soils in New York State beyond the scale of individual fields. These models require resource inventory data related to soil, climate, and land use. Several approaches relate land characteristics, soil management practices, and computerized environmental databases to predict and map soil qualities such as leaching potential. Over the past three years, a methodology was developed by faculty and staff in the Department of Soil, Crop, and Atmospheric Sciences to integrate a dynamic simulation model with environmental databases to map pesticide leaching potential at landscape scale. The lessons learned from that experience provide the basis for this article.

The modeling approach was based on LEACHM. LEACHM is a finite difference model designed to simulate the movement of water and solutes through layered and non-layered soils at variable spatial and temporal scales. Soil data were derived from USDA-Soil Conservation Service (SCS) State Soil Geographic database (STATSGO) discussed in the last issue of What's Cropping Up. Geographic information technology was used to combine land use and soil maps then extract relevant soil data for only agricultural soils on nearly level and gently sloping land. Long-term climate data by climate region were provided by the Northeast Region Climate Center at Cornell University.

Average values for clay content and bulk density (mid-points of ranges) and the lowest (worst-case scenario) value for organic carbon were used. Water retention properties were estimated using regression equations which related water retention to particle size, bulk density, and organic matter. Pesticide degradation rates and other properties were obtained from literature. Continuously-cropped corn was the agronomic practice of choice, and the soil was assumed to be fallow for the remainder of the year. Crop growth patterns and chemical application rates and times were the same for all simulations, and based on Cornell Recommends for Field Crops.

To produce maps of model results, leaching classes were defined by the proportion of pesticide leached in relation to the amount applied on an annual time scale. Each STATSGO map unit component (soil series) was classified as either high (>25%) or low (<25%) amount of pesticide leached in comparison to that applied. Each modeled soil series was weighted by the proportion of area the series occupied in the map unit. Four classes were established to generate maps indicating the proportion of each unit having high leaching potential (<25%, 26-50%, 51-75%, >75%). The original agricultural soil map was then reclassified to reflect the leaching potential of each map unit.

Significant results of this study indicate:

(1) Pesticide leaching potential is related to the amount and distribution of rainfall and soil organic carbon. More refined definition of climate regions using a denser network of climate stations and interpolation of climate variables for major landscape units not characterized by such stations would significantly improve the precision of leaching estimates. Organic carbon values are derived from organic matter estimates published in soil survey databases, estimates generalized for a wide spectrum of soils that do not necessarily reflect organic matter conditions for landscapes being modelled. Given the importance of this soil property in mitigating pesticide transport, improved methods are required for determining organic matter status for landscape units larger in size than farm fields.

(2) Leaching indices should be classified and mapped on the basis of predicted pesticide concentrations on an annual mass balance basis using a simulation model adapted to the quality of resource inventory data. Decisions regarding the type of dynamic simulation model to employ for landscape-scale estimates of solute transport must consider the scale at which the modeling is being applied and the nature of available environmental data at that scale. Quantitative comparison tests between model types us-

(See Mapping, pg 6)

FARM MANAGEMENT

Meeting Farming and Evnironmental Objectives through Whole Farm Planning

Keith S. Porter
Water Resource Institute

For decades, agricultural scientists and farm advisors have sought to maintain economic viability of farming as environmental regulations have increased. Despite these efforts, sustained success has not been achieved. Many reasons have been offered for this failure. One major reason is that farm practices developed to meet environmental goals are often recommended without fully considering their acceptability in terms of the whole farm as a business. This failure may be due to individual farm practices being developed and recommended by specialists. It is remarkable to reflect the range and number of specialists upon whom a dairy farmer may rely on (Animal Nutritionists, Parasitologists, Veterinary Entomologists, Veterinarians, Agricultural Engineers, Soil Scientists, IPM Specialists, Field Crop Specialists, and Economists). This list is not exhaustive. It is hardly surprising that we generally fail to develop specific recommendations for farmers, which adequately take into account the multiple inter-relationships in farm management with which the recommendations must be consistent.

Over the past two years, a new and ambitious program has been launched in Southeastern New York which is determined to solve the problem of meeting environmental goals consistent with farm business interests. Under the Federal Safe Drinking Water Act, New York City is compelled to apply strict standards in its watershed. The watershed produces high quality water for 9 million persons and covers 2000 square miles, an area about as large as the state of Delaware. Within the watershed are: parts of eight counties, fifty-four towns, twelve villages, and over 500 agricultural and horticultural operations. Historically, the most important category of farming in the watershed region has been dairy farming, and it is upon that the program is initially focused.

The program was established by an Ad hoc Task Force established jointly by the NYS Department of Agriculture & Markets and the NYC Department of Environmental Protection. New York City is providing 3.4 million dollars for a preliminary demonstration program in which 10 dairy farms are participating. Working directly with the farmers are several County Project Teams composed of staff from County Soil and Water Conservation District Offices, Cornell Cooperative Extension, and the US Conservation Service. The Cornell Team was established through the NYS Water Resources to provide scientific and technical support to the County Project Teams. To date, overall administration has been the responsibility of the NYS Soil and Water Conservation Committee. This responsibility is now shifting to the Watershed Agricultural Council established at the outset of the program.

The Cornell Group faces four principle challenges. First, a primary concern under the Safe Drinking Water Act is the risk to public health posed by water-borne parasites and other microbes. Agricultural research and extension has barely dealt with these problems to date. There is a critical need to determine the degree to which farm animals are sources of the parasites, the fate of those parasites in fecal material on the farm, risks to drinking water, and appropriate management methods to control the microbes. These questions are being addressed by a Cornell Pathogen Group under the leadership of Susan Wade (Diagnostic Laboratory). This challenge is sharpened by the need also to develop reliable and efficient laboratory methods to determine the presence and viability of the parasites. The two main parasites of concern are the protozoa, **Giardia** and **Cryptosporidium**. A second need is to determine the areas in the watershed, which because of sensitive hydrological conditions, justify special protective measures. This task is under the direction of Michael Walter (Biological and Agricultural Engineering).

The third and fourth needs are to develop methods by which integrated farm plans can be developed and the understanding transferred to County Project Teams. Whole Farm Planning is the term used for the program. Whole Farm Planning consists of several steps. First, an environmental audit of the farm is conducted in conjunction with a farm business assessment. The audit attempts to identify any existing water quality problems that justify remediation. The audit also diagnoses farm activities for which pollution prevention measures are desirable. As a result, a list of needs are identified. The County Project Teams then formulate management options for each need. Here lies the challenge. How can a set of options be selected which best serves the business interests of the farmer, while ensuring secure protection of water quality sufficiently for the 9 million persons who depend upon wholesome water from the watershed?

(See Farm Planning, pg. 6)

Integrated Nutrient Management

SOIL MANAGEMENT

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INTRODUCTION

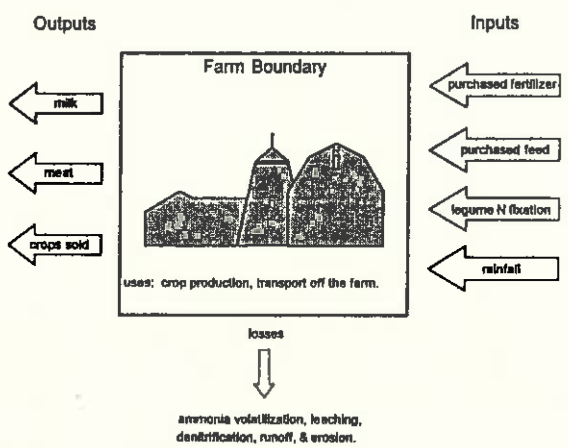
Nutrient management can have an impact on the economic and environmental well being of a farm and surrounding landscape. A well-designed nutrient management program should be implemented on farms to help assure an adequate and sustained supply of high quality feed, promote efficient nutrient recycling, and minimize nutrient loss. A nutrient management plan must integrate a considerable amount of information about the farm operation and requires a perspective of; 1) the movement and quantity of nutrients entering, leaving, and remaining on the farm, 2) the nutrient application schedule to ensure that the rate and timing of manure and fertilizer applications are in concert with crop requirements while minimizing loss, and 3) crop selection and management for providing quality feed, improved nutrient recycling, and reduced runoff and erosion.

An assessment of the quantity of nutrients entering, leaving, and remaining on a dairy farm is a good starting point in understanding nutrient cycling.

NUTRIENT FLOW

Nutrient management decisions are usually related to the movement of nutrients into, within, and away from the farm. The figure above is a simple illustration of nutrient flows on dairy farms. Typically, nitrogen (N), phosphorous (P), potassium (K), and other nutrients are brought into the farm in purchased feed and fertilizer. N is also imported on to the farm through the conversion of atmospheric N into protein by legumes and in precipitation (usually 5-10 lb/ac/yr). Nutrients leave the farm in products sold as milk, meat, and crops.

Nutrient Pathways on dairy farms.



Nutrients normally concentrate on livestock farms because more are imported than exported in products sold. A typical yearly nutrient balance for N, P and K for a 85 cow dairy is shown in the Table. The percent of the N, P and K that remained on the farm each year was 64%, 68%, and 66%, respectively. Purchased feed is usually the primary source and fertilizer the secondary source of imported nutrients. A study of nutrient balances on dairies across the state showed that the percent of the purchased nutrients that remained on the farm each year was fairly consistent regardless of farm size. However, size dictated the quantity of nutrients to be managed, and therefore, larger dairies require a proportionately larger land base to efficiently utilize nutrients.

An N, P, and K balance for an 85 cow dairy.

Category	N	P	K
	---tons/yr----		
INPUT			
feed	9.7	1.7	2.4
fertilizer	2.2	0.9	1.8
legume N fixation	1.1	0	0
	13.0	2.6	4.2
OUTPUT			
milk	3.8	0.68	1.00
meat	0.4	0.10	0.02
crops	0.5	0.06	0.40
	4.7	0.84	1.42
REMAINING, %	64%	68%	66%

The accumulation of nutrients challenges the farmer's ability to manage them in an efficient and environmentally friendly manner. One of the consequences of nutrient accumulation is that livestock manure becomes enriched with plant nutrients, making it a valuable replacement for commercial fertilizer. However, on many dairy farms, manure provides more nutrients than can be utilized by crops (especially P and K). Most of the surplus P and K shown in the Table remain in the soil, although some may be lost in runoff and erosion. Their accumulation is reflected in the long term increase in soil test P and K levels. Nitrogen does not accumulate appreciably in soil and much of it can be easily lost by ammonia volatilization, leaching, and denitrification.

(See Nutrient, pg. 6)

CROP MANAGEMENT

Choices in Growing Alfalfa, A Survey Report

Bill Pardee
Department of Plant Breeding

High yield and disease resistance are the top traits New York farmers seek when choosing alfalfa varieties. Each factor was listed by about 50% of the respondents in a survey of 600 dairy farmers that we conducted last year. Winter hardiness, longevity, and quality concerns were also noted, each listed by about 1/4 of the farmers. Seed price came in last, mentioned by only 4% of the respondents.

This survey was designed to learn from farmers what factors they considered important in choosing and growing alfalfa varieties. Results were to help breeders, extension workers and dealers to better anticipate farmer needs. Comparisons with a similar 1977 survey showed interesting trends.

To develop a representative sample, we mailed questionnaires to 600 farmers, chosen randomly from 6 different regions of New York State. About 30% answered, a good response for a mail survey. Farm size ranged from 10 cows to over 1000, with an average size of 110 cows and 86 heifers. Comparisons with 1977 results are shown in the table on pg. 7.

Fewer farmers listed longevity (29%) than in the 1977 survey (53%). This may reflect a trend toward tighter rotations by some farmers. More farmers listed disease resistance (49% vs 25%) as an important consideration. This may reflect the recent emphasis on resistance in company advertising and extension recommendations. Few farmers listed price as a major consideration in either survey. This suggests that most farmers consider variety performance more important than price.

In another question we asked farmers to note their major problems in growing alfalfa. Winter-kill (27%) and wet soils (22%) were the most common problems. Weeds and insects came next, both listed by 14%. Diseases were noted by only 7%. This seems surprising, given the major concern for disease resistance noted in farmer's criteria for choosing varieties (see first paragraph). Apparently the disease resistant varieties they select are working. Problems in establishment were noted by 13% of respondents.

Where do you get information, we asked, when selecting varieties? Most farmers listed several sources. Not surprisingly, about 80% indicated that they gained variety information from their seed dealers. Extension was also popular, with 70% noting their extension agent, Cornell Recommends or other extension sources. Farm magazines (articles and advertisements) were also important, listed by 39% of the respondents (up from 20% in 1977).

Moving to cultural practices, we asked about seeding practices. Of the respondents 63% used a grain drill, 23% used a Brillion seeder, and 7% employed fluid seeding. Most farmers (84%) mixed alfalfa with a grass, with timothy the most popular (64%). Bromegrass was second (15%), with smaller percentages sowing reed canarygrass, orchardgrass or ryegrass.

Seeding rates ranged from 8-20 pounds of alfalfa seed per acre, with 13-16 pounds being most popular (37%), followed closely by 17-20 lbs/acre (34%). Most grasses were added at 4-6 pounds per acre.

Only 29% reported using an herbicide on their seedings, with Buctril and Eptam the most popular chemicals. The other 71% did not use an herbicide. This was a shift from 1977, when nearly 50% of the respondents used an herbicide. The decline may have been due to the cancellation of dinoseb (Premerge) and the present lack of any cleared chemical for alfalfa-grass mixtures.

Many farmers (over half) used a small grain nurse crop. Oats was most popular (35% of all respondents), with triticales gaining popularity (15%). Wheat (6%) and barley (2%) trailed.

From this information breeders will note (1) high yield ability is still the top criteria for farmers in choosing varieties. Growers also want strong disease resistance, but are apparently finding adequate resistance in varieties now available. Winter hardiness is also important. Quality was noted less often, but was still important to 25% of the respondents. Seed price was rarely mentioned.

(See Alfalfa, page 7)

Pipeline Right-of-Way and Farmland: After the Pipeliners Have Left -- Monitoring and Followup

SOIL MANAGEMENT

John Lacey
NYS Department of Agriculture and Markets

In two earlier articles, Farming a "Dirt Highway" 1 and 2, you met transmission pipeline right-of-way planning, construction and restoration, focused on those techniques best suited for your Northeast soils. This concluding article offers several matters of farmland concern -- after the pipeliners are done.

Monitoring the Right-of-Way; and, Following Up

A "good" transmission pipeline project doesn't "end" after the massive construction and the initial restoration have been completed. A transmission pipeline enterprise, with a long-term interest in a region, wants and needs to maintain favorable relations with the farm operators along a right-of-way easement. A good right-of-way project will, in an ongoing manner, utilize the services of qualified agricultural specialists who are very familiar with: pipeline construction, your soils and crops. *What should an agricultural specialist do once construction is done?* The specialist is responsible for monitoring the disturbed farmlands for the effectiveness of the restoration work. *For how long?* Usually for at least two (2) full growing seasons after the pipeline is in service. *"What" kinds of things should my portion of the right-of-way be checked for, and "when"?*

Beginning with the first "when", allow for one winter of ground freeze and seasonal thawing action, as well as early spring rains. Now, for the "what" kinds of things to monitor. The first assessment must, at least, examine your farmland for trench settling, water seeps, vegetative cover, and residual compaction of the subsoil.

Trench settling. Although some trench "crowning" may have been applied during construction-restoration, unseen voids within the "trench", will slowly fill-in. Sometimes a trench will settle from four (4) to twelve (12) or more inches, across its width of eight (8) to fifteen (15) feet. New, imported topsoil should be applied (during firm, soil traveling conditions) to fully mitigate the settling. *What about using my soil from the areas adjacent to the trench?* Don't! If topsoil from the right-of-way is pushed into the depression it only reduces the depth of your fertile loam and creates a wider depression for surface water ponding or gullying. Insist on good soil material being brought in to correct the trench settling.

Water seeps. New water seeps, or "water boils", as well as wide zones of soil saturation are not uncommon along trenched rights-of-way, due to the de-stratification of the soil profile. Areas which never had spring seeps can have them within one to two years after the trench has been backfilled. Crop fields which had imperfect soil drainage, before the pipeline came, can have worsened drainage by the backfilled trench becoming a "saturation basin". These problems are resolved with the installation of "intercept" tile drain lines (some positioned across the right-of-way and others parallel with the trench), carried to a safe and adequate gravity-flow outlet, outside of the actual right-of-way if necessary.

Vegetative cover. If the planting of a hay rotation is poor, the right-of-way should be assessed for either a top dressing or a complete new seeding. Some pipeline projects will do later-than-normal initial reseeding and run the risk of insufficient root development and winter kill. In other instances, dormant weed seeds, finding the right conditions, will produce a "crop" which overtakes a new planting. Sometimes the weed can be controlled, if caught soon enough; while at other times the right-of-way is restored only by a second reseeding.

Subsoil compaction. Early spring is a good time for the agricultural specialist to perform the necessary field comparisons, measuring for subsoil density. *But I thought the pipeliners took care of subsoil ripping and final subsoil shattering before they left?* Maybe. But there can be a difference between the design function of the deep tillage tools and how they are actually utilized by the pipeline contractor, during initial restoration. Rough field checks are carried out during initial restoration to see how deep the subsoil shattering is -- but only inside of the right-of-way. *Why?* Because a real comparison of subsoil density inside of the right-of-way, with the density outside of the right-of-way, cannot be made until the subsoil moisture is adequate for testing, and, at a nearly equal proportion, i.e. the same inside the disturbed easement as out in the undisturbed portion of the field. This usually means waiting until the early part of the first spring season following the construction.

Accompany the specialist. Help check your affected fields. Watch the comparisons made with a cone-

(See Pipeline, page 7)

RESIDUES

(Mapping from page 1)

ing a standard set of environmental data is an important component of model selection for each study at any scale.

(3) maps of leaching indices should be used by decision-makers at scales no larger than 1:250,000 when using landscape-scale environmental databases due to the intrinsic and information uncertainty associated with the variability of soil and climate data, type of model, and quality of spatial data. Knowing the regional distribution of landscape units susceptible to pesticide leaching as depicted on maps serves to better inform decision makers on both the scope and level of effort required to develop improved environmental protection strategies or to define more detailed scientifically-based field studies.

The modeling approach used in this study is applicable at multiple scales, provided the relevant environmental data and knowledge are used at the appropriate scale. Modeling results are sensitive to the nature and quality of input variables at a given scale. Estimates of solute transport at field-scale require environmental data that reflect the complexity and variability of soil processes and microclimatic conditions. For most applications, interpretation of model predictions will be limited to the quality of environmental data, type of model, and knowledge of the soil user.

(Farm Planning from page 2)

The Cornell Group has made progress as an inter-disciplinary team. However, we are far from fully achieving our purposes. We seek to establish an "operational" systems analysis of dairy farming. Through this analysis we are confident farm business interests will be advanced while water quality is more securely protected.

The Cornell Group are:

William Ghiorse	Section of Microbiology
Stuart Klausner	Soil, Crop & Atmopsheric Sciences
Wayne Knoblauch	Agricultual & Resource Economics
Robert Milligan	Agricultural & Resource Economics
Hussni Mohammed	Veterinary Clinical Science
Alice Pell	Animal Science
Keith Porter	NYS Water Resources Institute
Thomas Richard	Agricultural & Biological Engineering
Donald Rutz	Pesticide Mgmt. Education Program
Susan Wade	Veterinary Diagnostic Laboratory
J. Keith Waldron	Integrated Pest Management
Mark Walker	NYS Water Resources Institute
Michael Walter	Agricultural & Biological Engineering

(Nutrient from page 3)

SUMMARY

Because nutrient accumulation is common on livestock farms, it is important to develop a nutrient management plan that ensures efficient recycling with minimal environmental impact. A important part of a plan is a critical analysis of the quantity of nutrients brought into the farm each year in purchased feed and fertilizer.

Over feeding and over fertilizing is economically and environmental unsound. Feed and fertilizer purchases should be scrutinized with respect to the *actual* nutrient requirements of the herd and crop rotation. Soil testing is critical to confirm the nutrient requirements of the crop rotation, and application rates should match these requirements. Feed analysis and profitable ration balancing assures economical production and herd health. Additionally, crop selection and soil fertility management can improve yield and quality, thereby, increasing nutrient recycling by reducing the need for purchased feed and fertilizer.

The success of a nutrient management program also depends on the attainment of surface runoff and soil erosion control and by the degree that manure is managed as a resource rather than a waste product.

A successful nutrient management program should include these basic concepts.

- do not over feed or over fertilize.
- soil test to determine crop requirements.
- analyze feeds and balance rations profitably.
- use manure to supply as much of the crops nutrient requirement as possible.
- base application rates on crop requirement and the nutrient availability in manure.
- manage the distribution, timing, and rate of application to maximize nutrient utilization and minimize loss.
- use good soil and water conservation practices to control loss.

(Alfalfa from page 4)

Agronomists and dealers will note the high use of grasses (85%), particularly timothy. Herbicide use is down, with Buctril and Eptam most common. Many respondents (35%) use nurse crops, particularly oats. Triticale has risen in popularity.

New York Alfalfa Surveys
1977 and 1992

What factors do you consider most important when choosing alfalfa varieties?		
% of Respondents	% 1977	% 1992
High yield	65	50
Disease resistance	25	49
Winter hardiness	26	29
Longevity	53	21
High quality	25	23
Adapted to wet soils	29	16
Price	5	4
What are your major problems in growing alfalfa?		
Winter-kill	6	27*
Wet spots, wet fields	15	22
Insects	27	14
Weeds	12	14
Establishment	16	13
Diseases	2	7
Longevity	15	7
Cost of seeding	3	4
Harvest weather	10	24*
No major problems	11	3

* This may reflect heavy winter losses in 1991-92 and the wet harvest season of 1992.

Information specialists will note the high attention to seed company sources and to extension information. Farm magazines also played a strong role, through both articles and advertisements. Most farmers listed several sources, suggesting that multiple routes may be most effective in information transfer on matters related to alfalfa.

(Pipeline from page 5)

type soil penetrometer: "Soil mechanical resistance" readings are performed incrementally, in relative pounds per square inch according to measured depths. If the average of the subsoil density readings across the disturbed easement are equal with or less than those outside of the right-of-way, it "passes". If the subsoil density inside the right-of-way is somewhat noticeably greater, it "flunks"; and remedial subsoil shattering should be scheduled.

The second "when" may occur at different times during the growing season. *"What" is it?* Monitoring the actual crop. The agricultural specialist should check the crop for relative quantity and quality inside and outside the right-of-way. Lingering problems of restoration can often be diagnosed by keeping track of a crop over the course of the growing season. Potential solutions can range from supplemental subsoil shattering, additional soil nutrients, topsoil replacement and the control of new spring seeps, to fine tuned surface grading for eliminating pockets of surface water ponding.

After a problem has been diagnosed, it should be corrected with supplemental restoration measures.

Your Cooperation

You and the agricultural specialist should work together as a team. When you observe a significant problem requiring followup, keep a record.

But I'm just glad to see the construction is finished and my field is back in one piece again. Maintain workable contact with the specialist and help -- by showing that person the obvious deficiency. Work together with the agricultural specialist to help plan the followup restoration. *I should plan on letting the pipeline people back on my field?* As followup work is needed -- absolutely! Having a right-of-way easement for a pipeline project isn't just a "one-way" mission of building and operating a transmission pipeline. It carries with it the responsibility of properly inventorying the land for effective restoration. If your land needs supplemental restoration, cooperate. Let the pipeline firm complete the work, responsibly.

You can contact John Lacey at (607) 255-1756.

Calendar of Events

Nov. 7-12	Amer. Soc. of Agronomy Mtgs., Cincinnati, Ohio. Contact ASA 608-273-8080.
Dec. 2	Cornell Seed Conference, Sheraton Inn, Ithaca, NY. Contact B. Pardee 607-255-1653.
Jan. 11-12	Empire State Soil Fertility Assoc., Inc. Meeting, Holiday Inn. Auburn, NY.
Jan. 19	Western NY Corn Conference, Sheraton Inn, Batavia, NY.
Jan. 20	Finger Lakes Corn Conference, Holiday Inn. Waterloo, NY.
Feb. 15	NYS Forage and Grasslands Council, Holiday Inn, Auburn, NY Contact K. Hoffman 607-334-9971.

What's Cropping Up? is a bimonthly newsletter distributed by the Department of Soil, Crop and Atmospheric Sciences at Cornell University. The purpose of the newsletter is to provide timely information on field crop production and environmental issues as it relates to New York agriculture. Articles are regularly contributed by the following Departments at Cornell University: Soil, Crop and Atmospheric Sciences, Plant Breeding, Plant Pathology, and Entomology. **To subscribe, send a check for $8.00 along with the form at the right.**

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