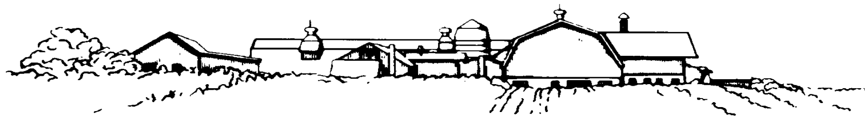

AGRICULTURAL NEWS

Chemung, Schuyler, and Steuben Counties

Volume 89 **April 2008** **No. 4**

Getting The Most From Your Corn

Rick Grant

Source: Miner Institute Farm Report

Higher priced feeds will remain the norm for the foreseeable future. A recent Doane's Agricultural Report (2/22/08) reported Midwestern corn at $4.98/bushel, distillers dried grains at $157/ton, and soybean meal at $342/ton. One year ago, the same commodities were $4.13/bushel, $126/ton, and $223/ton. The same Doane's Report predicted that this period of higher feed prices could last another 15 years. Between 2005 and 2007, common feed ingredients for dairy rations increased in price by over 60%. Corn price increased by 66%.

Now, more than ever, we need to efficiently extract nutrients from the feed ingredients in our dairy rations. Currently there's considerable interest in feeding lower-corn, lower-starch diets to lactating dairy cows in an attempt to reduce feed costs. Of course, the goal is really to reduce dietary corn grain and starch without compromising milk yield, or some other important measure of cow productivity and health. A key component of profitable feeding strategies will be ensuring that dietary starch is effectively used by the cow, and that only a minimal amount of starch actually ends up in the manure.

Several important factors influence the rumen fermentability and/or total tract digestibility of corn starch:

- Corn genetics (floury or vitreous endosperm, more or less digestible starch)
- Source of starch: barley > corn > sorghum in starch digestibility
- Proper particle size of grain and silage
- Moisture content at harvest
- Time in silo: starch becomes more digestible with time in the silo, particularly after 4 to 5 months.

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Inside…..

Cornell Cooperative Extension

Steuben County

Trading Post

For Rent – 100 tillable acres of land for rent. Manning Ridge Road, Campbell. Phone: 607-425-7733.

For Sale – Rissler 610 mixing cart, good condition for $2700.00. Phone: 607-733-5899.

Sheep Shearing - $4.00/head - $40.00 minimum. Phone: 607-695-2496.

Goat For Sale – One buck born 12/4/07-Boar-dairy cross for $65.00. Phone: 607-695-2496.

Steuben County
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Postmaster, send change of address to: Steuben County Agricultural News, Cornell Cooperative Extension, 3 East Pulteney Square, Bath, New York 14810

Upcoming Events

April 5 – Small Farm Workshop, Civil Defense Center, Route 54N, Bath, NY, 9 am until Noon. Topics: NYS-DEC Bureau of Private Land Services – Service Foresters – Who We Are and What We Do, Introduction to Farm Business Tax Issues and Marketing. Following this general session there will be breakout sessions on small fruit production and an overview of livestock production. For more information contact Kerri Bartlett at 607-664-2311.

April 18, 2008 - 2008 Allegany County Grazing Conference Impacts for Dairy Producers: Production and Profitability Friday, April 18th at the Catholic Church, 50 South Street, Cuba, NY

- 9:30 Registration
- 10:00 AM The Benefits of Grazing..beyond grass!
- 10:25 AM Using Small Grains and Brassicas to Extend the Grazing Season.
- 10:45 AM Whats in Your Milk Check?
- 11:45-12:15 Back to the Future with a Grass-Land Livestock Operation Jerry Brunetti
- 12:15-1:00 PM Lunch & Exhibitor Displays
- 1:00-3:00 Back to the Future with a Grass-Land Livestock Operation (continued) ”Looking at Healthy Forages, Healthy Herds, Healthy Farms”

Registration is required by Monday, April 14th. For more information and to register, please call Lynn at 585-268-7644 ext. 18. Cost is $15. Late or walk-in registration is $25.

Cover article continued

As a result of these and other factors, rumen starch digestion can range from <50% to

>90%. In the future there will be an increasing need to measure starch digestibility when formulating rations so that dietary starch is efficiently used. Feed testing labs are beginning to offer starch digestibility measurements along with measures of total starch content in a feed sample.

The relative importance of particle size, moisture content, and endosperm type was assessed recently by Dr. Pat Hoffman at the University of Wisconsin and shared with fellow nutritionists, agronomists, and forage lab managers at a meeting in Indianapolis. He related change in rumen starch availability to various measures of particle size, moisture content of the whole plant or grain, and endosperm type. His data showed that particle size is most highly correlated with starch availability, followed by moisture, and then endosperm type. So, it makes sense to evaluate your current corn processing and feeding strategies in that order. Have you evaluated the particle size of your supplemental grain? Have you evaluated the particle size of your corn silage and how well processed the corn kernels are? Make sure that the moisture content of your corn silage is appropriate for the storage structure and not too dry. Recent data from Europe show that the starch digestibility of corn silage begins to increase markedly about 4 to 6 months after ensiling. Be sure to adjust your ration formulation to account for these changes.

According to Dr. Jim Ferguson at the University of Pennsylvania, we can assess dietary starch digestion by measuring fecal starch content. If fecal starch is 4.5%, then that would equate to approximately 90% starch digestibility. For every 1%-unit decrease in fecal starch, the cow should produce about one more pound of milk. Although we should have been focusing all along on ways to increase the efficiency of starch and other nutrient use by the cow, prevailing feed prices demand that we do so now.

Forage Seedbed Preparation

Marvin Hall
PennState Extension

For a forage seed to have a chance of emerging and establishing, the seedbed must allow accurate seeding depth regulation and good seed—to—soil contact. Regardless of the seeding method (no-till, conventional tillage or broadcast) it is very important that seeding depth and seed—to—soil contact be a top priority. Planting forage seeds too deep can exhaust the energy reserves in the seed before the new seedling has emerged. This causes poor seedling establishment which can spell problems (increased weed competition, lower forage yields, and ultimately shorter stand life) for the stand. Ideally, forages should be planted about ¼ inch deep. Planting depths greater than ½ inch will decrease forage seedling emergence as much as 50%. Seed—to—soil contact is also important because it ensures that the seeds can absorb adequate water from the soil to germinate. Poor seed—to—soil contact slows water absorption and allows water to evaporate out of the seed. Good seed—to—soil contact requires a fine seedbed (no soil clods) and can be improved with press wheels or cultipacking after planting.

So when you are working the field to plant forages remember that a firm seedbed is needed to regulate seeding depth and a fine seedbed maximizes seed—to—soil contact. Creating a firm and fine seedbed is the whole point of preparing the seedbed and the first step to successfully establishing a great forage stand.

Fertilizer, Manure and Sod

Carl Albers

(From *2008 Cornell Guide for Integrated Field Crop Management* and *Nutrient Management:*

Crop Production and Water Quality, NRAES – 101)

Corn Nitrogen Requirements Lbs/Acre			
Type of Plowed Sod			
Years After Sod	Grass	Less Than 50% Legume	More Than 50% Legume
1	10 to 30	10 to 30	10 to 30
2	60 to 100	40 to 90	30 to 80
3	80 to 120	70 to 110	70 to 110
4	90 to 130	90 to 130	90 to 130

This table from the *2008 Cornell Guide for Integrated Field Crop Management* provides some general guidelines for how the nitrogen requirement for corn changes depending on the type of sod you are plowing down and how long a field has been in corn. There is a range in rates because nitrogen supply and requirements will change depending on if there are losses due to too much rain at the wrong time and the yield potential of any given field. So in other words, "a good legume or legume-grass sod will supply 100 to 150 pounds of N per acre or more, and a good grass or grass-legume sod will supply 75 to 100 pounds of N per acre to first year corn." Add to that 40 to 80 pounds of N from soil organic matter. Thus, a legume sod and the soil itself would supply approximately 200 pounds of N per acre, so only starter N would be required for top corn yields. Recent Cornell research conducted at numerous sites across NYS showed that for both optimum yield and quality a small starter N application (30 lbs N or less) is needed for first year corn following sods in the rotation, independent of timing of sod kill (late fall or spring), or percentage of legume in the sod.

Dairy manure supplies 2 to 5 pounds of N per ton, depending on the time and method of application. So twenty tons per acre of manure and the soil itself would supply 100 to 130 pounds of N, and only 30 to 50 pounds of N per acre would be needed for continuous corn. To retain as much nitrogen from liquid manure it should be incorporated ASAP after application. In general, daily spread manure will contain roughly 5 pounds of phosphorus and 9 pounds of potash per ton, and liquid manure 14 pounds of phosphorus and 30 pounds of potash per 1,000 gallons. The nutrient content of manure will vary from farm to farm so a manure analysis is the only way to know for sure.

The optimum economic N rate for corn after soybeans can be lowered by 20 to 30 pounds of N per acre. This adjustment should be applied only for the first year of corn following soybeans.

So priority for manure applications should be given to fields that have been in corn the longest, especially if soil tests are telling you that they are low fertility fields. Soil tests will pay for themselves easily just for pH and lime requirement determinations, not to mention letting you know the fertility status of any given field.

You probably can increase profitability by paying greater attention to crop rotations in your fields. Staying on a good rotation generally means you are going to have a higher percentage of legume in your hayfields, so forage quality will be higher, you will need to purchase less protein, and subsequent corn crops will need a little less nitrogen.

Protecting Your Nitrogen Fertilizer Investment

Richard Ferguson, Charles Shapiro
Extension Soils Specialists, University of Nebraska-Lincoln

With the dramatic increase in nitrogen fertilizer prices over the past year producers may be wondering if such large investments in fertilizer are worth it, however, current crop prices make application of recommended rates of N profitable. The thought of investing $100 or more per acre in nitrogen fertilizer may cause producers to think about how to protect that investment.

There are several management options producers can consider to protect their investment in nitrogen fertilizer, and insure that as much as possible is used by the crop this season.

- **Delay application.** The longer N is in the soil, the more likely that some of it will be lost – either by leaching, denitrification, or ammonia volatilization. However, multiple applications will require more trips over the field, and those costs need to be considered against the cost of other options.

- **Inject fertilizer below the soil surface.** Broadcast application of N fertilizers can increase the potential for ammonia volatilization (primarily for fertilizers containing urea) or for runoff. Immobilization of N in decomposing residue is also a concern with broadcast application. Placing N below the soil surface minimizes the potential for volatilization or runoff. If injecting fertilizer is not an option, surface banding of the fertilizer, instead of broadcasting it can help increase efficiency, though not to the degree of injection.

- **Use a urease inhibitor.** Agrotain® is the only product currently on the market labeled as a urease inhibitor, which protects urea-based fertilizer from ammonia volatilization. Agrotain® is applied to fertilizer, so the cost per acre depends on the rate of fertilizer applied. Currently, the cost of using Agrotain® with urea is $0.04 - $0.06/lb N. To protect 150 lb N/acre as urea with Agrotain® the cost will be $6.00 to $9.00/acre.

- **Use a nitrification inhibitor.** N-Serve® is the only product labeled as a nitrification inhibitor. However, dicyandiamide (DCD) is also an effective nitrification inhibitor, and is sold as a slow release fertilizer or fertilizer additive. Both products protect N from leaching and denitrification losses. N-Serve® is applied at the rate of 1 qt/acre, which currently costs $7.18 ($28.73/gal).

- **Use a slow or controlled release formulation.** There are a number of slow or controlled release fertilizer formulations on the market. These products delay the release of N compared to more traditional fertilizers such as urea or UAN solution, with the intent to match nutrient availability with crop demand. These products can help protect N from loss due to leaching, denitrification, or ammonia volatilization. One controlled release product is ESN®, a polymer-coated urea fertilizer from Agrium, which costs $0.10 to $0.12 per lb of N. Use of ESN® to protect 150 lb N/acre will cost $15 to $18/acre.

These options should be considered as insurance, rather than yield boosters. If the proper rate of N is applied and climatic conditions are such that the potential for N loss is minimal, there will not be any benefit from using these practices. Normally, there will be some potential for one or more N loss mechanisms to influence fertilizer availability, resulting in some yield protection from the use of these practices. The most appropriate conservation practice, or combination of practices, will depend on your cropping system, soils, fertilizer source, and climatic conditions.

Soil Compaction Reminders

Sjoerd Duiker
PennState Extension

With a long winter, lots of snow melt and spring rains, the potential is there to cause some serious compaction – so to minimize the risk keep the following in mind.

Subsoil compaction depends on axle load, not on contact pressure. This means that reducing soil contact pressure by using flotation tires or tracks will not reduce subsoil compaction, although it helps to reduce surface compaction and sinkage. If you travel on soil that is really too wet with axle loads of 10 tons or higher, you're likely causing subsoil compaction below 20-inches. Research has shown that this compaction is there to stay. Freeze/thaw and wetting/drying cycles will not remove this compaction, nor will biological forces such as earthworms, roots, or microbial activity. Subsoilers usually don't go this deep, nor can they completely alleviate this subsoil compaction (and at considerable cost!). Research in experiments in seven European and North American countries showed a 5% yield decrease due to subsoil compaction that lasted longer than 10 years. Although you don't travel on 100% of the field with high axle loads in one year, you will probably get there in three years, so a 5% yield decrease due to subsoil compaction is not unrealistic. The key to subsoil compaction avoidance is to reduce axle load. This can be done by reducing the load or increasing the number of axles.

Surface compaction is caused by high contact pressures. Road tires inflated to 100 psi and iron wheels cause very high contact pressures. However, if axle loads are low (say below 6 or 7 tons per axle), subsoil compaction may not be caused. Surface compaction can cause very high yield losses the year immediately following the act. Tillage does not completely alleviate surface compaction. In the same series of international compaction trials they found on average a 15% yield loss due to the combined effect of subsoil and surface compaction the first year after compaction. In some cases (especially clay soils) yield losses amounted to 50% in the first year. The soil was moldboard plowed, but this did not alleviate surface compaction completely. In no-till, of course, yield losses due to surface compaction can be a lot more dramatic. Surface compaction is alleviated eventually due to natural and human means, but typically causes yield depression for a 4 to 5 year period. Research from Kentucky has shown that in long-term no-till systems soils will recuperate from most surface compaction without tillage within one year. Using flotation tires or tracks helps to reduce surface compaction.

The key to soil compaction avoidance is to stay out of the field when it is too wet. If the soil is drier than the 'plastic limit' the threat of compaction decreases dramatically. A rough guide to determining the plastic limit is to take some soil and try to make a ball out of it. If that is possible, the soil is too wet for either traffic or tillage. Don't fool yourself by taking soil from the surface only.

Vydate Approved for Nematode Suppression

Carol MacNeil,

Cornell Vegetable Program

A Special Local Need 24(c) Label was recently approved for the use of Vydate C-LV (EPA Reg. No.352-532) on potatoes in NYS for the suppression of lesion, root knot and stubby root nematodes. Vydate C-LV was already labeled in NY for foliar use to control insects but this new label allows for pre-plant in-furrow application for suppression of nematodes. Research done by George Abawi, Comell, has shown that where a sufficiently high population of root knot nematodes exists, the use of a soil application of Vydate can increase potato yields. Damaging levels of root knot and lesion nematode have been found in potato fields on both mineral soils and muck.

From the label: "To properly assess nematode populations and determine if a Vydate C- LV treatment program is a suitable option, it is essential to take soil samples prior to planting." Fall is the ideal time for sampling, giving sufficient time to apply a fumigant if nematode populations are very high. Early spring sampling is also a possibility.

On-farm soil bioassays have been developed by George Abawi and Beth Gugino, Comell, to determine levels of root lesion and root knot nematodes. Fields are sampled similar to sampling for nutrient analysis. Collect and mix ten trowels of soil for each field. Then fill several 4 inch pots and plant 3 soybean seeds <u>or</u> 2 lettuce seeds or tiny seedlings in each pot.

Place in a warm, sunny place or under fluorescent lights for 3-6 weeks. We can assist you with rating the roots for nematode infestation.

The in-furrow treatment calls for applying Vydate in a 6 to 8 inch wide band covering the bottom and sides of the open seed furrow, behind the planter tube, at 2.1 to 4.2 pts/acre, depending on root knot nematode levels.

Foliar applications of 2.1 pts/acre can follow the in-furrow treatment to suppress nematodes later in the season. For root knot nematode, foliar applications are initiated at 1440 degree days F (base 41 degrees F) 6 to 8 inch deep in the soil, counting from the date of planting. Foliar applications must be watered in with irrigation or at least 0.5 inch of rainfall. Fertigation water should be buffered to a pH of 5.0 or less.

There are three different treatment plans depending on nematode levels in the soil. There are also special directions when alfalfa precedes the potato crop. The maximum amount of Vydate C-LV allowed per acre per season is 12.8 pints. Vydate is a Restricted Use Pesticide. **Users must have a copy of the label (SLN No. NY-O80001) in their possession at the time of application.** Pesticide distributors should be able to supply you with this label, or contact your local Extension office, in Bath, 607-664-2309. We can e-mail, fax or mail you a copy. Always read and follow label instructions.

Attention Steuben County Growers Federal Inspections of NY Certified Private Pesticide Applicators

The Federal Pesticide Recordkeeping Program will be conducting random inspections of certified private pesticide applicators in the State of New York this spring. The counties that have been selected for inspections are **Chautauqua, Steuben, Clinton, St. Lawrence, and Westchester**. The inspections will be conducted by APHIS investigators and a letter notifying the applicators that have been selected for inspection will go out prior to the inspections. The records must contain the following elements and be maintained for 2 years after the application:

- Brand or Product Name
- EPA Registration Number
- Total Amount Applied
- Date of Application
- Location of Application
- Crop, Commodity, Stored Product, or Site
- Size of Area Treated
- Name of Applicator
- Certification Number

Antibiotic Basics

David Wolfgang,
Extension Veterinarian, PSU

Antibiotics are important tools to help manage infectious disease in dairy cattle. While a very useful aid in the control of disease, antibiotics should never be viewed as a substitute for good management. Prolonged or improper use of antibiotics over time can or will selectively increase the population of resistant bacteria. Prudent use of antibiotics can reduce the risk of antibiotic resistance and minimize residue concerns.

No antibiotic can completely kill all the pathogenic bacteria during therapy for an infectious condition. Antibiotics have different modes of action, penetrate tissues differently, occasionally are inactivated by inflammatory substances or the bacteria themselves, or simply may not be effective against the bacteria in question. Some antibiotics are only effective against Gram positive (+) bacteria (e.g., Streptococcus spp, or Staphylococcus spp.), others only against Gram negative (-) bacteria (e.g., E. coli, Klebsiella, Manheimia, Pseudomonas), while others are considered broad spectrum and could be used against either Gram + or – bacteria. Mycoplasma are unique micro-organisms and can be quite difficult to control. Infection by Mycoplasma are frequently not eliminated with typical antibiotic treatment regiments.

Antibiotics inhibit the growth or kill bacteria by a variety of methods. Some antibiotics stop key bacteria functions (e.g., protein synthesis, energy production, cell well development, or cell wall integrity). For these reasons it is important to understand a few basics about antibiotics in order to make their use, when necessary, more effective. The following table contains a brief outline of some common antibiotic classes.

Gentocin, Amikacin ®	Primarily Gram -	Inhibit protein synthesis
Ceftiofur (Excenel ®)	Broad spectrum	Cell wall synthesis
Cephapirin (Today ®)	Broad spectrum	Cell wall synthesis
Ampicillin (Polyflex®)	Primarily Gram+;	Cell wall synthesis
Penicillin, Cloxacillin	Gram +	Cell wall synthesis
Micotil®Tylan®Erythromycin	PrimarilyGram+;Mycoplasma	Inhibit peptide bonds
Tetracycline, Florfenicol(Nuflor®)	Broad spectrum; Mycoplasma	Inhibit protein synthesis
Pirsue ®	Primarily Gram +	Inhibit protein synthesis
Sulfas	Broad spectrum	Inhibit thymidine or folic acid synthesis

To further complicate the use and choice of a particular antibiotic, not all antibiotics move uniformly into tissues. As an example, some antibiotics even if known to be effective against a particular bacteria family, when given in the muscle or sub-subcutaneously may not enter the mammary gland at levels sufficient to be effective. Further some bacteria may be present in tissue spaces, like joints or abscesses, again effectively isolating the bacteria from certain antibiotics. Viruses are not controlled by antibiotics. The use of antibiotics to treat purely viral infections is expensive, wasteful, and increases the development of antibiotic resistance.

This should help to emphasize the critical need for each farm to work closely with their veterinarian in designing therapeutic plans. To be effective a plan should include a diagnosis of type of bacteria likely to be involved, as narrow a choice of antibiotic as possible, an

understanding of the target tissue, likelihood of success, adequate dose level given for sufficient time, and good records to ensure proper withdrawal and/or withholding.

Costs and Risks Associated with Natural Service Sires

Michael O'Connor,
PSU Dairy and Animal Science Extension

In light of the recent tragic death of a Pennsylvania dairy producer by a herd bull I feel it is important to review once again the costs and risks of having a bull on the premises. Based upon a survey of Pennsylvania dairy producers, the major reasons listed by those who do not use artificial insemination for their heifers are the perception of lowered conception rates with artificial insemination (AI), difficulty or time involved with estrous detection, location of heifers was inconvenient for reproductive management and lack of restraint facilities.

Estrous synchronization programs have been used for 25 years and have been refined to minimize time spent for estrous detection and to manage an AI program for heifers and cows. Acceptable conception rates can be achieved with properly designed and implemented programs. For a relatively small investment most heifer facilities can be upgraded and equipped to provide restraint and handling facilities for heifers. In addition to administering treatments for synchronization and insemination, such facilities can also be used for vaccination, deworming, veterinary treatment, pregnancy examinations, and perhaps embryo transfer. There are solutions to the major reasons dairy producers do not use AI for their heifers.

Artificial insemination of dairy heifers provides numerous advantages. Foremost is the opportunity to improve the entire herd's genetic merit. The use of AI-proven sires generates a gain of $110 in milk production per year by their offspring compared to use of natural service (NS) sires. Related to the genetic merit from the sire component is the fact that heifers born from AI matings are genetically the best animals in the herd. These AI-sired heifers provide more quality replacements and a greater opportunity to cull animals of lower genetic merit. Approximately 30 percent of calves born each year are progeny of first-calve heifers. Heifer AI has a major impact on genetic improvement of the entire herd. Furthermore, calving ease information is available for AI sires. Minimizing dystocia is a major advantage of AI.

By using AI sires, dairy producers can use semen from several sires to minimize the risk of obtaining progeny from one low genetic merit sire whether from a natural service sire or an AI sire whose genetic evaluation declined as more information became available. Also, breeding dates are more likely to be recorded, calving dates more accurately predicted and appropriate dry periods planned. In a pasture-breeding situation, heifers with reproductive problems are not identified until considerable time is lost. These heifers would probably not calve at the optimum age of 24 months, resulting in lost profits.

Merchandising is another advantage for AI-sired heifers. If quality AI-sired replacements are available, then dairy producers can sell heifers based on genetic criteria. In addition, heifers tend to be the most fertile females in the herd, thus they are more likely to conceive to AI. Gender selected semen is now available and used for heifers. These advantages document the tremendous opportunity that exists with use of AI for heifers.

The fact that the AI sires are examined and tested for reproductive soundness and disease, and that semen quality and fertility are routinely monitored are additional benefits. Based on the results of breeding soundness examinations performed on sixty-six on-farm dairy bulls by one veterinary clinic in California, 26 percent of the bulls were considered unsatisfactory. Breeding to a subfertile or infected natural service sire will cause a significant delay in the interval to conception. Heat stress impacts bull fertility which can significantly set back herd reproductive performance.

The most frequently asked question is “what is the comparative fertility when lactating cows are bred by AI or NS?” As you can imagine, conducting well controlled studies to answer this question are difficult. However some comparisons from field studies have been summarized. Results from three studies conducted in Australia, Europe and California showed that AI breeding was equal or superior to natural service. In the European study, fertility of 20 pairs of cows bred either by AI or NS within a 600 cow herd were compared.

After three years the AI group had a shorter calving interval of 18 days. Results from a field study within one large California herd showed that 52% of the cows in the bull bred string (pen) were pregnant compared to 60% of the cows in the AI string.

Results of a comprehensive economic partial budget analysis comparing costs associated with NS and AI was conducted using data from large western dairy herds (University of California, Davis 2006). The investigators included explicit and implicit costs. Explicit costs were defined as out-of-pocket or accounting expenses involving actual cash payments, i. e., daily feed costs. Implicit costs were opportunity costs of lost milk yield and genetic improvement. For the natural service herds, it was assumed bulls were used exclusively for reproduction and managed using a rotational system. Health costs included breeding soundness examinations, blood testing, vaccines, veterinary care and foot trimming. Feed and labor costs were included. The AI herds used a modified Presynch/ Ovsynch ovulation control timed breeding program. These herds used 25% young sires and 75% proven sires with the maximum Net Merit of $500. There were numerous other expenses included for both groups. The model estimated the use of natural service sires in these herds averaged approximately $10 more in costs per cow/year compared to the AI program. The analysis was run numerous times over a three year period to account for changes in costs. Approximately 60% of the time, AI was predicted to cost less than NS. It should be noted that the natural service sires received breeding soundness exams and routine vaccinations which is not the case on most dairy herds where bulls are used.

Another index that is useful in comparing the economic merit of sires is Expected Net Return dollars, ENR$, developed by Dr. Gary Rogers animalscience.ag.utk.edu/ENR$ It is a tool that puts a dollar value of revenue for one unit of semen for a sire relative to a service from an average non-AI bull. ENR$ considers the cost of semen, relative conception rate, revenue and costs associated with daughters and future generations. It is also affected by a dairy producer's level of herd management and milk market. There are over 500 AI bulls on the ENR$ list that are expected to return more revenue per service to the dairy producer than a service by a non-AI sire.

So here is the take home message: there are significant costs and risks associated with natural service that may not be realized and should be considered by dairy producers using natural service for heifers or lactating cows. Secondly, and most importantly, it is your responsibility to provide a safe working environment for your employees and family members. Bulls are dangerous.

Earthworm Ecology and Sustaining Agriculture

Matthew R. Werner
Center for Agroecology and Sustainable Food Systems, University of California

Earthworms can play a variety of important roles in agroecosystems. Their feeding and burrowing activities incorporate organic residues and amendments into the soil, enhancing decomposition, humus formation, nutrient cycling, and soil structural development (Mackay and Kladivko, 1985; Kladivko et al., 1986). Earthworm burrows persist as macropores that provide low resistance channels for root growth, water infiltration, and gas exchange (Kladivko and Timmenga, 1990; Zachmann and Linden, 1989). Quality, quantity and placement of organic matter is a main determinant of earthworm abundance and activity in agricultural soils (Edwards, 1983; Lofs-Holmin, 1983), as are disturbances of the soil by tillage, cultivation, and the use of pesticides (Doran and Werner, 1990). This article will review recent information on earthworms as it relates to the sustainability of agriculture.

Earthworm Ecology

Earthworm species can be classed in one of three morpho-ecological groupings (Bouche, 1977 [summary in Lee, 1985]). Epigeic species live in organic horizons and ingest large amounts of undecomposed litter. These species produce ephemeral burrows into the mineral soil for diapause periods only. They are relatively exposed to climatic fluctuations and predator pressures, and tend to be small with rapid generation times. A common example is *Eisenia foetida* (redworm, manure worm) which is used in vermicomposting.

Endogeic species forage below the surface, ingest large quantities of soil with a preference towards organic rich soil, and build continuously ramifying burrows that are mostly horizontal. These species are apparently not of major importance in litter incorporation and decomposition since they feed on subsurface material. They are important in other soil formation processes including root decomposition, soil mixing, and aeration.

Species which build permanent, vertical burrows that penetrate the soil deeply were termed anecics by Bouche. These species are detritivores and come to the surface to feed on partially decomposed litter, manure, and other organic matter. The permanent burrows of anecics create a microclimatic gradient, and the earthworms can be found shallow or deep in their burrows depending on the prevailing conditions. Anecics have profound effects on organic matter decomposition, nutrient cycling, and soil formation. The most common examples are the nightcrawlers sold by fish-bait dealers consisting of *Lumbricus terrestris* and Aporrectodea longa.

Palatability of different types of litter to earthworms may depend on nitrogen and carbohydrate content, and the presence of polyphenolics, such as tannins (Satchell, 1967). Earthworms prefer materials with a low C/N ratio, such as clovers, to grasses which have a higher C/N ratio (Ruz Jerez et al., 1988). Colonization of litter residues by microorganisms also increases palatability (Cortez et al., 1989), as does leaching of feeding inhibitors.

Benefits of Earthworms

Deep burrowing species such as *L. terrestris* can burrow through compacted soil and penetrate plough pans, creating channels for drainage, aeration, and root growth (Joschko et al., 1989). Recent work by Shipitalo and Protz (1989) elucidated some of the mechanisms by which earthworms enhance soil aggregation. Ingested aggregates are broken up in a liquid slurry that mixes soil with organic material and binding agents. The defecated casts become stable after drying. Stewart et al. (1988) also presented evidence that earthworms initiate the formation of stable soil aggregates in land degraded by mining. In forest ecosystems, earthworms, especially litter feeders such as *L. terrestris*, can consume all the litter deposited on the soil surface within a period of several weeks (Knollenberg et al., 1985) or months (Satchell, 1967). Incorporation of litter by earthworms in apple orchards can be an important mechanism for preventing outbreaks of scab fungus, spores of which are transmitted from litter to new foliage by spring rains. Raw (1962) found a high correlation between *L. terrestris* biomass and apple leaf litter incorporation, with over 90 percent of litter incorporated during the winter when this species was abundant. Incorporation of surface litter may be an important function of earthworms in no-tillage agroecosystems.

Introduction of earthworms to areas not previously populated has led to improvement of soil quality and productivity in New Zealand grassland (Martin, 1977), on drained Dutch polders (Van Rhee, 1977), in heathland in Ireland (Curry and Bolger 1984), and in mining spoils in the U.S. (Vimmerstedt and Finney, 1973).

Earthworm casts are sources of nutrients for plants. Lumbricids in a pasture soil produced casts that contained 73 percent of the nitrogen found in the ingested litter; indicating both the importance of earthworms in incorporating litter nitrogen into the soil and the inefficiency of nitrogen digestion by earthworms (Syers et al., 1979). Earthworms increase the amount of nitrogen mineralized from organic matter in soil. Because nitrification is enhanced in earthworm casts, the ratio of nitrate-N to ammonium-N tends to increase when earthworms are present (Ruz Jerez et al., 1988). Nitrogen-fixing bacteria are found in the gut of earthworms and in earthworm casts, and higher nitrogenase activity, meaning greater rates of N-fixation, are found in casts when compared with soil (Simek and Pizl, 1989).

Earthworms may increase levels of metabolic activity in soils, as measured by the amount of CO_2 evolved, yet nematode abundance and microbial biomass may decrease (Yeates, 1981; Ruz Jerez et al., 1988). This occurs because earthworms reduce the amount of substrate available to other decomposers, and because earthworms ingest other decomposer organisms as they feed. This process would tend to accelerate nutrient cycling rates.

Management Effects on Earthworms

Earthworms are not favored by tillage, and in general the greater the intensity and frequency of disturbance, the lower the population density or biomass of earthworms (Haukka, 1988; Mackay and Kladivko 1985; Edwards, 1980; Gerard and Hay, 1979; Barnes and Ellis, 1979). Agricultural soils are generally dominated by species adapted to disturbance, low organic matter content, and a lack of surface litter. Earthworms are dependent on moderate soil moisture content, and cultivation tends to have a negative effect on earthworms by decreasing soil moisture (Zicsi, 1969). Some common agricultural lumbricids are *Allolobophora chlorotica*, the Aporrectodea caliginosa species complex (*A. trapezoides, A. turgida*, and *A. tuberculata*), and L. terrestris. Species common to organic rich habitats, such as *E. foetida* are rarely found (Lee, 1985).

Earthworm populations are usually significantly depressed in cropped fields relative to pasture or undisturbed lands. Lumbricids in a South African soil were decreased by cultivation to about one-third of original levels. *Aporrectodea trapezoides* was less affected than Eisenia rosea, possibly because it is able to burrow more deeply in the soil and escape the zone of disturbance (Reinecke and Visser; 1980). Gerard and Hay (1979) reported 93 earthworms per square meter in normally plowed plots, including *A. caliginosa, A. chlorotica, A. longa*, and *L. terrestris*. Earthworm abundance increased in plots that received disk cultivation, or no-till treatment. Earthworm abundance doubled in no-till soybeans as compared with plowing (Mackay and Kladivko, 1985).While a major function of tillage is to decrease bulk density of soil and increase porosity, it only increases microporosity. Macropores, which may be of physical or biological origin and which can play an important role in conducting water rapidly into the soil, are destroyed by tillage. For instance, a 67 percent decrease in the rate of infiltration after plowing a tropical forest soil was attributed to the destruction of earthworm burrows. Infiltration in an adjacent arable soil, which was initially much lower than in the forest soil, increased by 23 percent after plowing because the surface crust was broken (Aina, 1984). Infiltration increases in cropped soils when an organic mulch is added in the fall, due to the increased activities of earthworms in these soils and the production of macropores (Slater and Hopp, 1947). Soil compaction caused by agricultural traffic can also decrease earthworm populations (Bostrom, 1986). A study in Denmark found that 89 tons/acre of manure was optimal for increased earthworm abundance and biomass (Andersen, 1980). *L. terrestris, A. longa*, and *A. caliginosa* were increased by manure, while *A. rosea* and *A. chlorotica* were not influenced. The Rothamsted Experiment Station plots in England which received manure for 118 years also had increased earthworm abundance, and inorganic fertilizers in this case caused decreases in earthworm populations (Edwards and Lofty, 1974). Heavy applications of inorganic fertilizers may cause immediate reductions in earthworm abundance (Edwards, 1983).

Organic mulches enhance earthworm habitat by moderating microclimate and supplying a food source. In corn plots in Pennsylvania, earthworms were most abundant in the fall in treatments that were not plowed before winter and where corn residues had been chopped and left as a mulch, regardless of whether the plots were organically or conventionally managed (Werner and Dindal, 1990). Effects of agricultural pesticides on earthworms depend on the chemical used. Herbicides tend to have low toxicity for earthworms, but can cause population reductions by decreasing organic matter input and cover from weed plants. Fungicides and fumigants tend to be very toxic to earthworms. Application methods may have unique effects on ecological groups of soil animals. For instance, the fungicide benomyl caused reductions of field populations of earthworms. Anecics such as *L. terrestris* were most susceptible to surface applications, and were less affected by incorporation of the pesticide into the soil. Because *L. terrestris* forms permanent burrows, it does not come into contact with subsurface soil beyond its burrow. However; endogeic species such as *A. caliginosa*, which continuously extend their burrows as they feed in the subsurface soil, were most susceptible when benomyl was incorporated (Edwards and Brown, 1982).

Enhancing Earthworm Populations

There are many creative ways in which a farmer can manage for earthworms. A first step might be to determine what earthworm ecotypes are present, and how abundant they are. Endogeic species are most commonly found. These are useful, but a mixed community including anecic species as well would be even more beneficial, especially for incorporation of surface matter. Direct inoculation is one possible method, but transferring blocks of soil (one cubic foot each) from an area with a large earthworm population into a farm soil might work better. It is also important to consider what species should be introduced based on local soils and climate. Much of our knowledge about earthworms concerns species of one family, the Lumbricidae, which are native to moist temperate areas of Europe. The spread of these earthworms has paralleled European colonialism around the world. They are the only earthworms present in the northeastern US and Canada, where glaciation killed the native fauna. In areas that have a native earthworm fauna, Lumbricids often dominate in disturbed habitats. Morphologically, Lumbricids are more muscular than any other family of earthworms, suggesting a greater capacity for burrowing (Hartenstein, 1986).

One management idea for introducing desired species is to set aside a small area of land on a farm to be managed exclusively as an earthworm reservoir. If needed, the soil could be limed to bring it near pH 7, fertilized, and a cover crop established and cut periodically to provide an organic mulch as food and physical cover. In this area a community of the desired species could be established and built up. From this reservoir blocks could periodically be taken and introduced into the field. Rate of spread would vary with species and conditions in the field. *Lumbricus terrestris* is capable of travelling at least 62 feet on the soil surface in the course of one evening foray (Mather and Christensen, 1988). This is a long term process for establishing earthworms, and would only be successful if ample organic matter was supplied to the soil where earthworms were being introduced, and if physical and chemical disturbances of the soil were minimized. Organically managed perennial crops would be ideal for this method.

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Soybean Seed Germination

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It is fitting that soybean seeds are light yellow in color. Seeds of high-performing varieties are as precious as gold. Farmers may have trouble obtaining the seed of the varieties they want if something goes wrong this spring and they need to replant.

Seed companies sell high quality seed. But, this year they may need to lower their standards, slightly, to meet demand. Farmers and their advisers should remember that all seed sold in Missouri must possess a tag that contains important information about the quality of the seed. However, the methods used to calculate germination percentage are not very helpful for determining what might happen to the seeds under field conditions.

Planting high quality seed does not guarantee obtaining a good stand. Bad things happen to good seeds. Seed germination begins with water absorption. Water absorption changes the seed from a nearly dormant organism into a living, functioning seedling. As seed tissues imbibe water, enzymes necessary for growth are activated, stored reserves break down, and cell division and expansion occur. During germination, damage to seeds and seedlings may result from rapid water imbibition, chilling injury, low oxygen availability, and attacks from pests.

Soybean seeds are often planted into soils with less than optimal characteristics for rapid germination and emergence. The seed environment is often characterized by soil moisture contents so high that oxygen is excluded and the presence of opportunistic pests.

Although water absorption is required for germination, under some circumstances water can be absorbed too quickly. As tissues and cell components absorb water they greatly increase in size. If too much water is absorbed too quickly, cell walls can rupture causing cell death. Soybean seed coats moderate water absorption. They rapidly absorb water and then slowly release water to the other seed tissues. Seed coats that contain cracks cannot function properly, and injury from rapid water absorption is more likely. Seeds not handled carefully during harvest, storage, and transport are likely to contain cracks that might be invisible to the human eye, but can cause problems during germination.

Low oxygen availability is common in wet soils. Water in soil pores excludes oxygen needed for seedling growth. Initially, water absorption by seeds is not dependent on oxygen. In fact, both dead and live seeds absorb water. But, once water content of soybean seeds exceeds

50 percent continued water absorption depends on energy released by seed respiration. Oxygen demand increases rapidly and that oxygen must come from air within soil pores. Seeds with low vigor are less likely to withstand short exposures to low oxygen availability.

As seeds germinate, cell contents, rich in sugars, leak into the surrounding soil. Pathogens use this leakage as an energy source, multiply, and invade the seed. Cell content leakage is much greater from poor quality seeds or from seeds damaged by less than gentle handling. Germinating seeds and young seedlings are also attractive food sources for soil borne insects.

Because supplies of many elite soybean varieties are extremely tight this year, the opportunity to replant poor stands with high yielding varieties is limited. So to achieve good stands select high quality seed and handle seed gently.

To Plant, or Not to Plant: A Question of the Forest

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Forest regeneration is always a topic of discussion among forest landowners. Many have recently had a timber sale, or want to increase the diversity of the trees they have, while others would like to convert some of their pastureland to forest. But, how do you know whether natural regeneration is the right path for your forest? Natural regeneration, new seedling growth, comes from the seed bank in the soil as well as seeds from surrounding trees. Some seeds can travel quite a distance, so if you have mature trees of your desired species in the area, odds are there should be some of their seeds around. If you don't have good natural regeneration, or you don't like the species that are regenerating another option is planting seedlings. Seedlings of almost every species can be purchased for planting.

So, how do you know if you have good natural regeneration? If you can go into your woods and see seedlings and saplings of all sizes and many different species, your forest has good natural regeneration and you don't really need to plant.

If you don't see any smaller trees, those less than one half inch in diameter, you have poor natural regeneration and could consider planting. Some of the reasons for poor natural regeneration are: wildlife pressure (deer browsing), closed canopy (no light reaching the forest floor), or a large fern or other "weed" population in the understory. You will have to take steps to correct any of these problems you may have before planting, and often by doing so, natural regeneration will come in on its own.
Another reason for planting forest trees is to increase the number of species growing in your forest to increase diversity. Some forests may only have a few species growing in them, especially if they were planted. Forests with low diversity are more susceptible to problems from insect or disease outbreaks. You can also convert your forest from one type to another or improve wildlife habitat by planting trees.

Some landowners have fields they would like to convert to forestland. One way to do this is to let the field grow, and usually within several years, depending on deer impacts, woody plants will start to establish. However, this natural reforestation can take many years before large trees are visible, and they may not be the desired species. To jump-start the process, plant desirable trees. Planting in fields is generally pretty easy, as the ground is flat and mechanical tree planters can be used.

So, why wouldn't you plant trees? Reasons include the desire for open habitats, the labor of planting, costs of planting, and the potential for mortality of seedlings. A common barrier for landowners is usually the labor involved in planting. Planting in a field is simple enough, but planting in a forest is usually done by hand, and can be complicated by existing tree roots. Cost is also a consideration, small softwood seedlings range between $30 and $60 per 100, and hardwoods $60 to $120 per 100. If you plant with an 8x8 spacing, that's about 680 trees, or $400 per acre, plus the costs of planting and seedling maintenance.

Another concern is seedling mortality. Your seedlings should come with instructions; follow them. Many seedlings die due to improper planting, drought, wildlife damage, or damage caused by humans. Planting and care of the seedlings before and during planting is crucial. Seedlings are delicate and need proper water and storage, don't let your investment be wasted. Wildlife browsing is also a big killer of seedlings. If you have a high population of animals (deer, rabbits, voles, etc.) that feed on trees during the winter, realize that you will probably lose some seedlings. Consider managing your wildlife population or protecting the trees with tree shelters, which is an additional cost.

When purchasing seedlings, make sure you buy plants that are suitable for your site and hardiness zone. Before choosing species, evaluate your site. Do you have areas of standing water; are there dry pockets; is there a lot of shade; what is your soil type? These are some of the questions you should ask yourself, and then find trees to match your specific soil conditions. To help with winter hardiness, buy trees from a grower with a climate similar to NY. The NYS Department of Environmental Conservation and many county Soil and Water Conservation Districts also sell trees well suited to NY.

There are other great reasons to plant trees including for windbreaks, wildlife habitat, energy conservation, riparian buffers or aesthetics. Forests provide us with a myriad of benefits. Planting might be a good way to benefit your forest. For additional information on forestland activities that will benefit your objectives, visit Cornell's forestry website at www.ForestConnect.info, contact your local office of Cornell Cooperative Extension, or join the New York Forest Owners Association through their website at www.nyfoa.org