New York Farm Viability Institute
David Grusenmeyer
Executive Director
dgrusenmeyer@nyfvi.org

NYFVI has funded several precision agriculture projects over the past several years. As NYFVI has become more involved in the precision agriculture arena it is apparent that there is significant interest among farmers, consultants, businesses, federal agencies, as well as Cornell, SUNY Cobleskill, and SUNY Morrisville researchers and educators. It is also equally apparent that there is a significant need for communication and awareness regarding who is doing what and who has what resources and interests.

The whole precision agriculture arena has a web of components and needs that require a wide range of skill sets and resources, and will need the expertise of the entire industry, not just any one organization or individual. A few examples that come quickly to mind – assisting farmers with precision agriculture research interests, designing large scale field research experiments, implementing and managing experiments on farms, data collection, data analysis and interpretation, formulating recommendations, developing individual field prescriptions, integrating prescriptions into farm management systems, helping farmers understand and utilize the technology, producing students with the necessary knowledge and skills, and creating precision agriculture internship opportunities on farms and in agribusinesses. NYFVI has already started efforts to help facilitate communication and coordination between these various industry facets.

Precision Agriculture Applications
Alan N. Lakso
Horticulture Section, Cornell University
anl2@cornell.edu

Apple Crop Model Supporting Precision Thinning and Crop Control (Lakso, Robinson, DeGaetano, Eggleston) – A dynamic simulation model of the carbohydrate status of the apple tree was found to integrate the effects of daily weather variations on the physiology of the tree. This in turn estimates the sensitivity of the tree to chemical thinners used to control the crop level and quality of the orchard, a critical but notoriously inconsistent practice. Growers can use this real-time information to make precision adjustments for greatly improved consistency, profitability and sustainability. This Cornell Apple Carbohydrate Model is programmed online to provide growers precise guidance both in time and over geographical variations.

An Inexpensive Microtensiometer for Monitoring of Soil and Plant Water Status (Stroock, Lakso, VanEs and Santiago) – New York has extremely variable soils and extremely variable weather leading great variation in soil and plant water stress in time and over space. Monitoring such variation effectively in soils is not feasible now due to the expense of such instruments, and monitoring the internal status of plants is not currently feasible. We have used nanotechnology to develop an electronic microsensor (about 5 x 5 mm) to monitor continuously the water stress of soils and woody plants as part of inexpensive probes. The sensors work over large ranges of stress and are currently being integrated into small, rugged probes with data-logging or wireless capabilities.
An Online GIS System for Basic Vineyard Site Evaluation in New York (Lakso, Martinson, Institute for Application of Geospatial Technology, Auburn) - The rapidly growing wine industry in NY is looking for excellent sites for vineyards as the best quality grape varieties are very sensitive to temperatures, especially cold. Except for Long Island, there are very limited number of such sites. To help prospective growers gather critical basic data on climate, geography, and soil characteristics of sites in NY state, we have developed a GIS-based web site (www.nyvineyardsite.org) to allow user to navigate locations and obtain over 12 layers of critical information for vineyards in only a few minutes. Launched in 2009, usage has grown over the years.

Precision fruit spraying in New York
Andrew Landers and Tomas Palleja Cabre
NYSAES, Cornell University
andrew.landers@cornell.edu

Precision spraying allows fruit growers to apply pesticides only to the target canopy or fruit; to apply the correct quantity according to canopy volume, density, growth stage; and to apply products in an economic and environmentally sound manner. At Cornell University we have conducted research into methods of adjusting both liquid spray and airflow according to the dimensions of the crop canopy. In both cases this adjustment was made using information provided by a multiple array of ultrasonic sensors mounted on a vertical mast that scans canopy vegetation. The sensors send signals to a control board that in turn selects the correct number of nozzle blocks or manifolds that can then emit spray according to the canopy. The same sensors and controller is able to position the actuator of an adjustable air louvre, or the speed of rotation of a fan, thus adjusting airflow according to crop volume.

Knowing how much spray has been applied to fruit crops is important for traceability and farm management. We have developed two systems of monitoring spray application and sprayer location based upon rtkGPS and RFID cards; both systems have proven useful in monitoring spray use.

ValuAg Network Co-operative
Jim Dutcher
SUNY Cobleskill
DutcheJM@cobleskill.edu

The ValuAg Network is the farm to fork online directory and exchange services for everyone in the food industry. Our mission is to serve everyone, small-to-large in the food chain, from farm to fork, by providing a comprehensive smart network of information, products, and services to farmers, suppliers, distributors, processors, wholesalers, retailers, restaurants, and consumers. We are the local, national, and world online exchange, resource and link into buying and selling food products. ValuAg services will be designed to give especially the small-to-medium ag/farm food produces access to resources and services and allow them to compete as if a larger ag/farm/food producer or organization. Because food security is real and the climate changing around production economics, along with the global demand affecting supply and monoculture putting mass failure at risk, ValuAg will assist with online services pertaining to sustainable practices, increasing yields, and increasing demand while decreasing costly and wasteful energy and water consumption, as well as optimizing any pesticide, fungicide, and fertilizer use. Our services will help reduce the 15-30% crop waste at the farm AND the additional 40% wasted along the entire supply chain. ValuAg will also help in the increasing of demand for local growers/buyers and reach the over 100 million consumers and businesses that are within a day’s drive via our online marketplace and exchange. The ValuAg Network Internet business startup will kick-start in 2016 where over the five year period grossing $863 million while projected to employ over 300+ high tech workers (computer programmers, mobile application developers, database experts, and ag/farm/food research & science experts) in the Southern Tier and upstate NY regions.
Grape growers of all sizes and market segments across the U.S. are challenged to remain economically competitive while reducing management and environmental inputs required for production. The potential for data-driven spatial vineyard management to improve production, economic, and environmental efficiency is significant but the adoption of precision agriculture techniques has been low because tools for sensing, processing, and integrating complex soil, canopy, and crop interactions for effective variable rate management do not exist in perennial cropping systems. In a newly funded SCRI project, we propose to use mobile sensors to collect and integrate spatial data on vineyard soil, canopy, and crop characteristics; validate and transform the data into useful management information; develop and test data-driven variable-rate vine management; create end-user Internet based tools for semi-automated spatial data processing and management; model and measure the economic benefits from adoption across a range of vineyard types and conditions; and develop outreach materials to facilitate well-informed adoption decisions. The goal of this project is to improve vineyard productivity, fruit quality, profitability and sustainability through an innovative, science-driven, and approachable precision viticulture platform for all sectors of the U.S. grape industry.

Precise Agriculture through the Eye of a Plant Breeder

Michael Gore
Plant Breeding and Genetics Section, Cornell University  
mg87@cornell.edu

The application of high-throughput plant phenotyping (HTPP) to continuously study plant populations under relevant growing conditions creates the possibility to more efficiently dissect the genetic basis of and select for dynamic traits such as daily biomass yield. Towards this end, mobile, HTPP systems that deploy sets of sensors to simultaneously measure canopy temperature, reflectance, and geometry and record climatic factors have been developed or are in the process of being developed for field-based applications in plant breeding and crop management. As a complement, small unmanned aircraft system (UAS) co-robots that work side-by-side with growers are being developed to assess levels of crop disease, in order to breed for resistance, to monitor crops for potential losses and to predict, track and respond to epidemics for national and global food security. In addition, user-friendly mobile apps that converge novel advances in image processing and machine vision for field based, HTPP and crop management are being built and deployed in breeder networks for cassava and wheat.

Cornell SPEAR Program

Quirine Ketterings
Department of Animal Science, Cornell University  
qmk2@cornell.edu

The mission of the Cornell Nutrient Management Spear Program is to assess current knowledge, identify research and educational needs, conduct applied, field and laboratory-based research, facilitate technology and knowledge transfer, and aid in the on-farm implementation of strategies for field crop nutrient management, including timely application of organic and inorganic nutrient sources to improve profitability and competitiveness of New York State farms while protecting the environment. Precision agriculture technology plays an important role. Our current work focuses on assessment of accuracy and precision of forage yield monitoring equipment, assessment of field spatial variability and its implications for plant and soil sampling as tools for nutrient management, development of a New York algorithm for sensor-based on-the-go nitrogen management, evaluation of use of field management zones for yield and resource allocation and responsiveness of crops, and we are exploring options for use of unmanned aerial systems for more time efficient and effective decision making at the field level. (http://nmsp.cals.cornell.edu).
Automated Integrated Weed Management: Challenges and Opportunities

Stephen L. Young
Soil and Crop Sciences Section, Cornell University
sly27@cornell.edu

During the past decade, it has become possible to conduct on-farm, real-time assessments of crops and pests, such as weeds. Robot technology promises to reduce the amount of labor needed to effectively assess and control weeds. As a consequence, true integrated weed management (IWM), which takes into account all relevant spatial and temporal scales, is within reach. However, even with advanced technology, several challenges remain. In terms of technology, occlusion of weeds by the crop and harsh environments present a challenge. In terms of socio-economics, growers are concerned that technology is replacing the human element of managing agriculture cropping systems. Finally, in terms of science, improved cross-disciplinary collaboration is needed between biologists, who know the most about agricultural systems, and engineers, who develop mechanical and automated solutions, in order to make the advances that are necessary to address critical global food needs and protection of the natural resource base. It will take not only technology, but also a roadmap for overcoming these challenges and move IWM to a level that makes it more applicable, widely adopted, and truly integrated. Within the past 10 years, I have conducted research, published papers, submitted grants, and written an entire book on the topic of automation and weed control. My most recent activities are through the Northeastern IPM Center’s Signature Program in Advanced Production Systems, which includes robotics, UAVs and sensor and computer technologies, and collaborating with colleagues in other disciplines to layout a roadmap for the development and adoption of automated integrated weed management.

Articles of interest by S.L. Young (click on title to link to the article):

- When resistance is futile: bring in the robots to pull superweeds
- Precision and automation weed control technology
- Automation: the future of weed control in cropping systems
- Moving integrated weed management into the future
- True integrated weed management

Adapt-N and Field Profitability Analysis

Harold van Es
Soil and Crop Sciences Section, Cornell University
hmv1@cornell.edu

Adapt-N is a cloud-based computational tool that combines soil, crop and management information with near-real-time weather data to estimate optimum N application rates for corn. It functions at the field, zone or full VRT level, and has recently been licensed and commercialized (adapt-N.com). Using 115 on-farm strip trials in Iowa and New York we demonstrated that the tool increases grower profits by $27 per acre while reducing environmental losses by 38%. Multi-N-rate trials in IN, OH, WI, and NY showed that Adapt-N closely estimates the Economic Optimum N Rate, and performs better than traditional static methods.

We also developed methodology to evaluate site-specific profitability from yield monitor data and found that fields can be classified into “economically sensitive”, “clear profitability”, and “all profitable” depending on the field specific characteristics. On many fields, unprofitable zones can be identified for alternative management. We also used EC and NIR sensors (Veris Opti-Mapper) to identify yield zones in fields, and found EC measurements to be more valuable.
Using NDVI Images to Optimize Vineyard Sampling Protocols
Jim Meyers and Justine Vanden Heuvel
Horticulture Section, Cornell University
jev32@cornell.edu

Using a previously developed sampling optimization model combined with a heuristic optimization algorithm, we determined the most efficient sampling protocols for a vineyard block to accurately capture canopy variability as expressed by NDVI images. Required sample size was reduced by up to 69% and distance traveled was reduced by over 90% compared to random sampling.

Precision Ag Research Project: Optimizing Variable Rate Seeding in NYS
Savanna Crossman
Corn and Soybean Growers Association
savannacrossman@hotmail.com

This project was initiated in 2013 by a group of growers who recognized the need for a variable rate seeding model that was adapted to the soil and climatic conditions of New York State. Participating growers across the State have been planting field scale research plots and collecting high resolution soils data on ½ acre grids since that time. In 2015 the project partnered with Cornell to sponsor a graduate student to analyze the data and create the model. For each field, the model will create a planting prescription that selects hybrid categories and population rates given certain soil properties/conditions. As the model evolves, the project hopes to add more data layers such as precision weather and UAS layers. The project is always looking to add new participants in order to build the dataset.

Fertility Management Utilizing Electrical Conductivity Mapping
Joe Dunn
Helena Chemical Co.
DunnJ@helenachemical.com

- Fertility inputs are a major cost of crop production
- 2 goals with fertility management
  - Properly evaluate current soil fertility
  - Provide an appropriate recommendation that satisfies crop need (Right rate, Right place are top priority)
- Electrical conductivity (EC) mapping is a BMP that supports the goals of fertility management
- EC data is collected using Veris machine
- EC data is strongly correlated with soil textures (sand, silt and clay).
- Geo referenced EC data is used to create management zones based on soil texture
- Soil sampling strategies are applied based on EC zones (texture)
- EC sampling is an improved method of sampling because it reduces the tendency to mix soil textures into a single sample resulting in possible improper recommendations
- Why sample by management zones based on soil texture:
  - Provides optimum lime and fertilizer recommendations based on the soil characteristics associated with each zone (CEC, buffer capacity, water and nutrient holding capacity)
  - Provides optimum placement of lime and fertilizer applications based on the soil characteristics found in each zone
- 10 plus years of experience using electrical conductivity mapping to make lime and fertilizer recommendations
- Applications of lime and fertilizer can be made based on EC zones with confidence that crop inputs will be optimized
- Additionally, electrical conductivity “zones” are a good platform to support other agronomic decisions such as seeding rates, nematode management and yield evaluations.
Science based solutions for Sustainable Agriculture
(or more moo, less poo)

Caroline Rasmussen
Agricultural Modeling and Training Systems LLC
caroline@agmodelsystems.com

Agricultural Modeling and Training Systems (AMTS) is a global company based in Cortland, NY, offering expertise and tools for ruminant nutrition and management. AMTS licenses the Cornell Net Carbohydrate and Protein System (CNCPS) from Cornell University.

CNCPS is a sophisticated model developed to predict requirements, feed utilization, animal performance, and nutrient excretion for dairy cattle, beef cattle and other ruminants using accumulated knowledge about feed composition, digestion, and metabolism in supplying nutrients to meet maintenance, growth and lactation requirements. Model inputs include air temperature, wind speed and how many steps the cows take. The model can balance for individual amino acids and the chain length of carbohydrates. Using this model our clients are able to use optimization algorithms to maximize animal production and farm income while minimizing potential pollutants such as excess nutrients in manure. The CNCPS model has been used to implement and research Precision Agriculture since 1998. The AMTS implementation of CNCPS quantifies and allows optimization of diets subject to nitrogen and phosphorus excretion and methane and total carbon losses.

AMTS software is used in 26 countries and is available in 7 languages. AMTS also provides technical consulting, workshops and webinars concerning ruminant nutrition and management. Recently AMTS has added products that allow integration of the ration formulation tools with feed mill and manufacturing software. This integration increases animal feed industry efficiency and safety by eliminating redundant data entry and errors. We are continuing to increase the integration of our products to data collection and remote control of feeding at the farm level.

AMTS products increase livestock efficiency. Animal diets formulated using our products maximize milk, meat and fiber production while minimizing cost and nutrient excretion. AMTS products are based on the latest science are highly accurate, have a user friendly interface and excellent company support.

Agricultural Consulting Services Inc.
Jack van Almelo
Manager
jackv@dairyone.com

Agricultural Consulting Services Inc. (ACS) is an independent crop and environmental compliance consulting company that prides itself on adapting its crop management services to each farm’s situation. Today ACS creates subfield breakouts using EC soil mapping, grid sampling, and relative yield maps, and provides variable rate seeding and fertility recommendations. Along with traditional GIS referenced soil sampling ACS offers high density subfield sampling with the Falcon Automated Sampler. ACS also works with adaptive nitrogen management including the use of optical sensors and the Adapt-N Model.
Mastitis accounts for the vast majority of antibiotics used on most dairy farms. As a general rule, mastitis is caused by bacteria infecting the mammary gland. Not all mastitis cases will benefit from being treated with antibiotics. In some cases, the bacteria is no longer there; in others, the damage is already done, so treatment has no effect; and in some cases, antibiotic treatment is necessary, but a 24-48 hour delay in starting treatment does not affect the outcome.

A milk culture can identify what pathogens are involved. It currently takes 24 hours for the bacteria to grow in culture. Pathogen data allow selective treating of cows. A pilot study showed a 60% reduction in antibiotic use for mastitis, significant economic savings, and no change in outcomes. The system is being implemented on additional dairy farms.

Ursa Space Systems Inc.
Derek Edinger
Satellite Manager

Ursa Space Systems Inc. (Ursa) is a geospatial services company located in Ithaca NY. Ursa has a unique spacecraft design with a low cost, synthetic aperture radar (SAR) which provides rich data products at day, night, and in all-weather conditions and a scalable cloud architecture to cost effectively serve a wide variety of markets. This technology and service can support precision agricultural needs by providing crop area, type, height, moisture content, and change in crop features (emergence, tasseling, etc.) in all weather conditions.

Ag Leader Technology
Travis Green
Territory Manager
tgreen@agleader.com

Twenty years ago the field of precision agriculture was relatively unknown, and Ag Leader Technology was a brand new company in diligent pursuit of making a name for itself. What has evolved over such a short period of time is truly remarkable. Today, Ag Leader is the leading name in precision agriculture and has grown to over 300 employees across the globe in North America, Europe, South America and Australia. Ag Leader has experienced significant growth from its beginnings as a yield monitor company, and now offers a growing array of planting, application, harvest, water management, and software solutions for all brands of equipment.

Corning Hyperspectral Imaging Technologies for Precision Agriculture
Xavier Lafosse
Commercial Technology Director – Advanced OpticsLafossex@corning.com

Corning Incorporated has a long history of innovations in optical materials, components and complex optical systems. Over the past decade Corning Advanced Optics division has developed both multispectral and hyperspectral imaging systems. Corning’s high-performance hyperspectral imaging and remote sensing solutions, spanning from the visible to the infrared, combine the lowest size, weight and power (SWaP) in the industry with uncompromising performance. This enables deployment for challenging applications in limited payload and/or size constrained environments. After a successful product introduction into the Aerospace and Defense sector, Corning is currently extending its product offering into industrial markets, including the precision agriculture market. Our imaging solutions enable agriculture field surveys at various altitudes and spatial resolutions, thanks to dedicated equipment and
software specifically optimized for satellites, manned aircraft, or unmanned aerial vehicles (UAVs, drones). Similar hyperspectral systems are also commercialized to enable the development and validation of innovative agricultural applications in the laboratory, prior to or in conjunction with field deployment. The rich spectral content of this imaging technology, combined with accurate georegistration, will enable a wide range of applications to address the challenges of modern agriculture, from crop yield improvement to the reduction of environmental impact related to water, pesticide, and fertilizer consumptions. While spectral imaging technologies are just emerging in precision agriculture, the overall supply chain remains fragmented and partially connected. Successful implementation of these imaging technologies will rely on our ability to develop strategic partnerships between agronomic consultants, imagery solution providers, custom application developers, academic research, and farm owners and operators.

To learn more about Corning Hyperspectral solutions:

**Aerial Inventory, LLC**

Peter Hyland  
Owner/Chief Financial Officer  
aerialinventoryllc@gmail.com

A Remote Sensing and Aerial Data Collection company. Specializing in Multi-Spectral imagery and UAS technology to work with NY Ag Producers. Use GIS to analyze and guide the day-to-day, crop-to-crop, season-to-season growing needs of your farm.

Every flight is fully customized to your farm, and your needs. Data is kept confidential and never given to a third-party. Although we sprouted in the Finger Lakes Region, we are willing to grow into other parts of NY. Optimally set up for 100+ acre operations. Per acre pricing. 100% Legal and insured.

Better data = Better growing decisions, One flight at a time.

**Voss Vertical**

Steve Welles  
Chief Financial Officer  
swelles7@gmail.com

Safe and reliable vertical takeoff and landing aircraft are a dream that has eluded aircraft designers since the 1960s. We have finally realized that dream...

Our elegantly simple design delivers the range and speed of an airplane with the capability to takeoff and land anywhere, without compromising control, safety, or reliability at any point during the flight.

The aerodynamics have been carefully optimized to compliment the onboard flight controllers, enabling seamless transition between hovering and forward-flight modes. This allows our aircraft to fly beautifully at any speed.
The increased availability of high resolution data and computing power has spurred enormous interest in "Big Data". While analysts typically source data from a wide variety of agencies, even within the United States Department of Agriculture there does not exist a comprehensive data warehouse with which researchers can interact. This leads to massive duplication in efforts, inefficient data sourcing, and great potential for error. The purpose of this talk is to provide a brief overview of this state of affairs within the community. An overview of a prototype warehouse is also provided, and thoughts on future directions.