A new interface for NEWA's decision support tools: tailored by user preferences

Project Leaders

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Introduction

Users of the Network for Environment and Weather Applications (NEWA) include growers of horticultural and agronomic crops, consultants, ag industry personnel, Extension educators, and faculty. NEWA is open-access and the second iteration of the website's collection of 35 tools, "version 2.0", is at the website address http://newa.cornell.edu (Olmstead et al 2020). Users needed an updated NEWA with responsive web design to make information easily and readily available on smart phones and tablets (Olmstead and Carroll 2018). NEWA also needed updated technology to provide better and more efficient weather data quality assurance. "Version 3.0" of NEWA is nearing completion and we are in the phase of tool rebuilds — insect models are complete, plant disease and crop production models are underway.

Our major goals to improve NEWA include facilitating access to tools and improving weather data quality. NEWA connects 717 weather stations in 28 states. The network combines meteorological data with interactive IPM and crop management tools to save sprays and improve crop quality. Growers benefit from NEWA's interactive IPM and crop production tools because NEWA directly supports and enhances IPM practices on the farm. Everyone using NEWA would recommend NEWA to other growers (Carroll 2008, Olmstead and Carroll 2018, Olmstead et al 2018).

Objectives

Our first objective was to create a responsive design for mobile-optimized user experience with geo-specific attribution. A responsive design makes the user-interface more intuitive and NEWA tools easier to use and view, whether on desktop or mobile devices. We prioritized the building blocks for NEWA, defined the

requirements for all components of the responsive NEWA website, and conducted user tests. The mobile-ready NEWA website addresses the end-user priorities of providing local attribution, saving biofix and user input information, and instantly delivering IPM decision support.

Our second objective was to improve data quality via automated screening and coordinated communication. We developed a system to facilitate the correction of erroneous precipitation, temperature, relative humidity, solar radiation, and wind speed data to enhance the accuracy of the weather-driven crop and IPM tools in NEWA. These variables are essential to the algorithms used in the decision support tools available in NEWA. Improved data handling is the foundation of being able to instantly deliver results.

Methods

A project advisory panel was formed with 42 members, including growers, faculty, Extension specialists, state partners, weather station owners and other stakeholders, who contributed to and advised us on user experience, website architecture, tool design, tool functionality and beta testing. Our project advisory panel participated in specific areas to advise NEWA development. We sent out mini-surveys to growers via the Your NEWA blog and to NEWA State Coordinators via email on topics related to user experience research and geo-specific content. Our grower advisory panel took part in user experience (UX) research on an insect degree-day model and two plant disease forecast models comparing the existing design with a draft responsive design to determine needed visual elements to allow at-a-glance pest status or crop risk, as well as perspectives on tables and charts of model outputs.

Our Extension stakeholders gave 155 invited presentations about NEWA at numerous Extension meetings, grower meetings, conferences, and other venues. At each, they informed the audience about NEWA, the improvements underway, and the positive impact on IPM practices of using the NEWA decision support system, frequently asking the audience about their ideas for improving NEWA. We published 85 articles, and produced seven podcasts on NEWA for grower audiences, climatologists, meteorologists, and agricultural scientists. The venues for these have included journals, the Your NEWA blog, newsletters, trade magazines, and technical and annual reports.

Input from stakeholders was obtained through our project advisory panel via Extension-led meetings, grower conferences, a Computing and Information Science (CIS) undergraduate internship, a CIS Master of Professional Studies project, a survey of NEWA users (Olmstead and Carroll 2018), user experience and web architecture analyses conducted by Cornell Information Technologies Computer Development (CIT CD), and web strategy workshops. During the Stakeholder Innovation Workshop led by ITX Corp, Rochester, NY we identified the NEWA mission, major areas of need, and set the stage for reviewing and prioritizing web content. The NYS IPM Program, the Northeast Regional Climate Center (NRCC) and CIT CD worked together on various aspects of the project.

An innovative approach for developing the NEWA website and associated user profile, weather station metadata, model results, and weather data displays was finalized. One-on-one, UX research on navigation, existing content labels, ease-of-use, and conceptual understanding of webpages by CIT CD informed NEWA's design. Our project advisory panel aided this effort. Geo-specific partner logos and resources were obtained. We worked with CIT CD for architecture, design and Americans with Disabilities Act (ADA) compliance to heighten UX when interacting with the responsive NEWA decision support system.

Databases required for NEWA's back-end were created: weather station metadata, Auth0 login, user input, common model template, and regional content system. To protect our users and our network, we put in place NEWA data use policy agreements and disclaimers. The 35 distinct NEWA model specifications were analyzed to aid modernization via a common model template fostering implementation into tools and enhancing UX.

Weather data quality control tools that allow viewing, selecting, invalidating or editing weather data were developed to support communication between growers and NEWA personnel on erroneous data, fostering the ability to edit data of concern. A portal for NEWA State Coordinators to access the tools and query the main weather variables on secure websites was developed. We provided training to state coordinators and other key personnel on how to use the data quality processes and its web interface.

Results and Discussion

The NEWA user interface features partner institution logos and resources of the user, based on geographic location, and responds to whatever device is being used. The regional content system database benefits the NEWA end user by creating an experience that is in accordance with their local and regional expectations for crop production and IPM.

NEWA Home now displays weather data from the weather station closest to the user and acknowledges the weather station owner that provides data to NEWA. The interactive weather station map loads quickly supporting searching, zooming, and panning. Two landing pages, Weather Tools and Crop & IPM Tools, buoy simplified navigation. Using a strong call out, "The Tools I Want, Where I Want" in Home's center, the user is invited to login and create a profile for their Dashboard (Fig. 1). Recent Your NEWA blog posts are featured. The NEWA Blog, Get Help, Profile and Login reside in the header and Partners, Become a Partner, About Us, and Press Room in the footer.

The user interface for each NEWA tool, shown for Apple Maggot in Figure 2, features controls on the left: station selection, date of interest, hide/show toggles for tool elements. Tool elements are grouped in user input, management guide, results table, results graph, and environmental variables table. Background information for each tool is found in more info, acknowledgements, and references. Users can download results data as Excel-compatible comma-separated values (CSV) files, and graphs as portable network graphics (PNG) files. All 35 NEWA insect degree-day models, plant disease forecast models, crop production models, and weather data queries will use the model UX template so NEWA users have consistent feel and reliable access to the weather-based, real time crop and IPM tools.

The user input database automatically stores a user's Dashboard profile preferences and model-specific information, such as the green tip biofix date for apple scab. This database directly benefits the NEWA stakeholders, especially growers, because they won't have to repeatedly enter their IPM or crop data into the NEWA tool each time, saving them a significant amount of time over the course of the season.

NEWA's weather data uses a single common access routine for all models, improving model-to-model fidelity, limiting data passed from the server to the user's device, and returning only data needed by the specific model. The common access routine and computation on the server improves model responsiveness, especially needed in rural locations with limited internet bandwidth. Our database of the National Digital Forecast Data predicts future conditions and is obtained in the same way as the observed data, streamlining data access. The improved data handling will boost UX and enhance NEWA's capacity to build future tools.

Our partner NEWA State Coordinators have access to their state's weather station data via an online data entry system. The Weather Station Database will benefit all NEWA stakeholders (growers, consultants, and extension educators) and will provide reporting on outages, as well as owner attribution for the weather station to users.

For temperature and precipitation, hourly observations are compared to published state records for the highest and lowest daily temperatures and most daily precipitation. The observations are further compared to independent gridded daily temperature and precipitation data sets and flagged if over a pre-set limit. Temperature observations also are compared to two neighboring stations, from NEWA and the National Oceanic and Atmospheric Administration, and flagged if over a pre-set limit. The between-station check is also

applied to humidity and solar radiation. Humidity values are flagged if they exceed or fall below the physical limits of 100% or 0%, respectively. For solar radiation, physical limit checks are also applied, between zero and a high limit not possible astronomically. Additional quality screening algorithms for soil temperature, soil moisture and leaf wetness are being adapted by the NRCC from work, funded by the USDA Natural Resources Conservation Service, to screen these variables in the Soil Climate Analysis Network (SCAN) and Tribal SCAN station networks.

The quality control checks run automatically every week, examining the prior 14 days and returning a count of flagged observations, to identify stations that chronically report suspect data. A human analyst can query counts of flagged data and the total number of days and hours that failed a particular check for the weather station is tabulated. Using this tool, the analyst can determine if the site is problematic, contact the owner to suggest maintenance, and edit invalid data.

The National Digital Forecast gridded data are being integrated as a backup data source for weather stations that fail to report data, either intermittently or for a period of up to one month. Inclusion of these data greatly improves the reliability and loading speed of the NEWA tools.

We are building an accurate, responsive and geographically relevant NEWA website. We are now completing rebuilds of all tools — insect models are complete, plant disease and crop production models are underway. The complexity of rebuilding all models into interactive tools with responsive architecture created challenges, as well as opportunities, for the NEWA team.

Beta testers unanimously praise design and navigation, which makes sense because we listened to our stakeholders and built the NEWA UX they envisioned. The NEWA community is keenly interested in continuing to learn about project outcomes and how to use the responsive NEWA tools to benefit their crop production practices. The NEWA version 3.0 website will launch in 2021.

Outcomes and Impacts

Increased use of digital IPM decision support systems like NEWA results in more growers making better pest management decisions with less pesticide input (Carroll 2008, Olmstead and Carroll 2018). NEWA's renewed architecture now delivers geo-specific attribution for appropriate place-based extension outreach on devices as small as phones. Common building blocks used to reconstruct the 35 IPM models into responsive NEWA tools (Fig. 2) were delineated and pave the way for future growth and easy upgrades.

A NEWA Dashboard (Fig. 1) will display what the user wants from the locations they want: easy to set up through NEWA's user profile. The profile backend will store essential biofix and crop information to drive fast and accurate IPM forecasts for growers. We have developed the required back-end databases and front-end design elements that will heighten positive user experiences when interacting with the responsive NEWA decision support system.

To support NEWA data quality, we utilize forecast data and our weather station data editor tool to provision an accurate and reliable decision support system. Improved navigation comes via an interactive NEWA map and streamlined landing page designs that echo our UX research.

When growers have access to reliable, weather-based, real time NEWA models, IPM practices increase on the farm, preventing plant disease, insect, and crop loss, reducing unnecessary inputs, and minimizing health, economic and environmental risks.

Figure 1. A screenshot of the NEWA Dashboard. The Dashboard was set up by a user in New York State who has chosen Appleton, NY as one of their favorite weather stations. They have chosen to include apple maggot, codling moth, oriental fruit moth, and San Jose Scale NEWA tools on their Dashboard. The Weather Station Summary can be edited to show the

weather variables of interest to the user. All NEWA Weather Tools and a Regional Radar are links on the Dashboard. Other Weather Tools, Other Crop & IPM Tools, and Other Decision Support Systems can be placed as links on the Dashboard. The apple maggot summary is open and shows brief results for the current day, which is January 12, 2021 in this example.

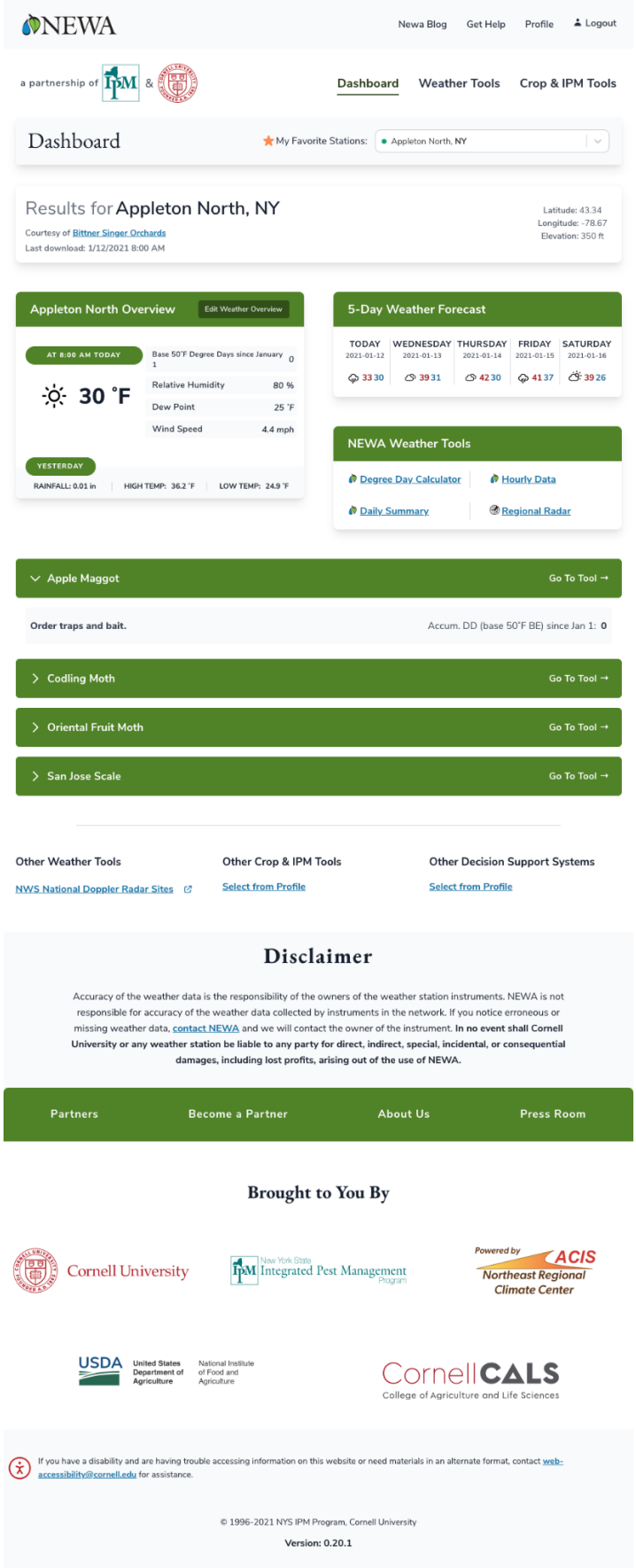
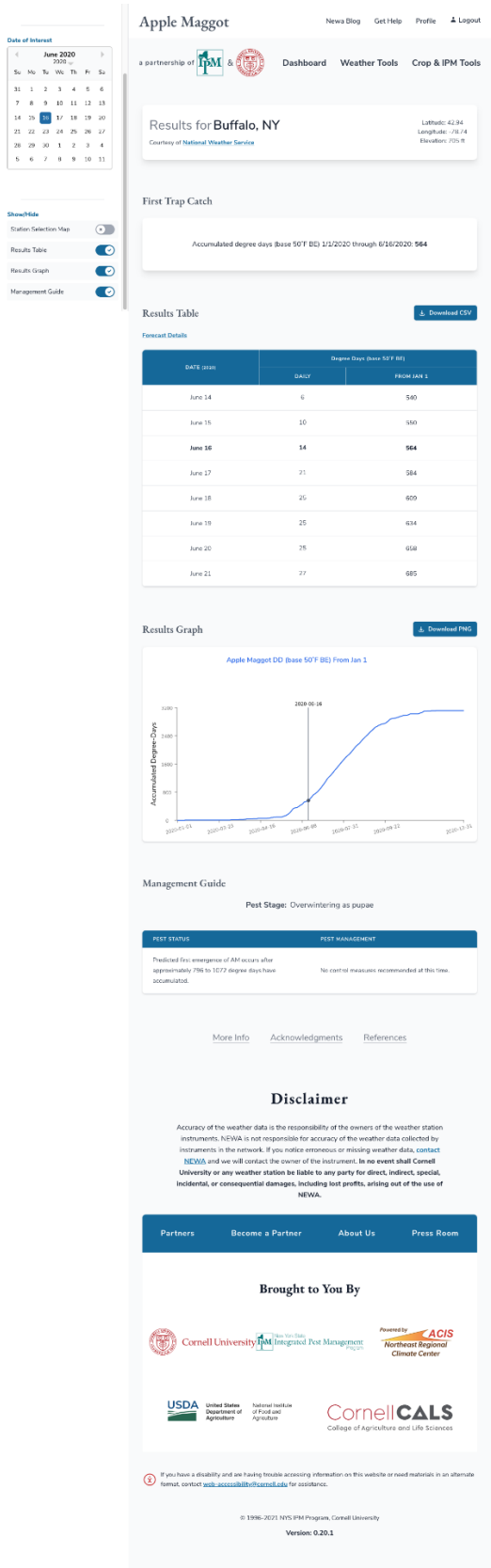


Figure 2. A screenshot of the NEWA Apple Maggot Tool. The date of interest is June 16, 2020 and the chosen weather station is Buffalo, NY. First trap catch user entry has not yet resulted. Grouped on the left are the tool controls, Date of Interest and the Show/Hide toggles for tool elements (Station Selection drop down not shown). The major tool elements are grouped under First Trap Catch (always on), Results Table (default on), Results Graph (default off), and Management Guide (default on) (Station Selection Map, default off, is not shown). When the user input box appears for first trap catch, the trap catch for orchard block can be entered and the last date entered will be saved for the weather station location.



References cited

Carroll, J.E. 2008. Impact of NYS IPM Program's Network for Environment and Weather Awareness (NEWA) on agricultural production. NYS IPM Program Project Reports 2007-2008, NYS IPM Pub 506: 261-267.

Olmstead, D. and Carroll, J. 2018. The Network for Environment and Weather Applications: 2017 Survey of Impacts and User Insights. NYS IPM Program Project Report. Cornell University eCommons. 9 pp.

Olmstead, D., Carroll, J., Weigle, T., Grant, J., and Petzoldt, C. 2018. Grower Valuation of the Network for Environment and Weather Applications. Poster, 9th International IPM Symposium, Baltimore, MD.

Olmstead, D., Carroll, J., Weigle, T., Seaman, A. and Grant, J. 2020. NEWA (Network for Environment and Weather Applications) 2019: A Year in Review. NYS IPM Program Project Report. Cornell University eCommons. 9 pp.