BIOAg Project Final Report

Title: Stabilizing the OFoot Decision Support Tool for Interdisciplinary Research

Principal Investigator(s) and Cooperator(s): Lynne Carpenter-Boggs (PI), David Huggins (co-PI), Bryan Carlson

Abstract:

The online agricultural carbon calculator, OFoot, provides a user-friendly interface suitable for not just researchers, but also producers and students, to estimate whole farm carbon footprints. OFoot continues to be a key component to many research, extension, and educational efforts. New planned projects require the tool to be stable, easily maintained, and have good performance. The original state of the tool did not meet these requirements due to the poor quality of its hosting environment and lack of long-term financial support. To ensure that the tool continues to benefit research and education relating to organic and sustainable agriculture in the future, the tool needed a new hosting environment. This project first determined the best environment for long-term cost-effective hosting, then migrated the tool to the new host, then tested its functioning in the new environment. The OFoot tool, now stabilized in a virtual machine hosted by WSU CAHNRS Information Technology, will be supported by the USDA-ARS Northwest Sustainable Agroecosystems Research unit using long-term guaranteed funds from the USDA-ARS funded program.

Project Description:

Outputs

Overview of Work Completed:

A cost-benefit analysis of four hosting options was conducted. The analysis assessed five criteria: startup costs, maintenance costs, impact on performance, impact on continued development, and impact on interoperability. Resulting from the analysis, a virtual machine hosted by CAHNRS Information Technology was provisioned and a migration strategy was outlined. Following the migration strategy, the web application was cloned from the old host to the new host and final integrity tests were conducted. Once the tool, on the new server, passed all tests, a final migration step occurred where the old host was deactivated.

Methods, Results, and Discussion:

<u>Methods</u>

Tool migration consisted of 4 steps; provisioning of a virtual machine, configuration of the virtual machine, setup of the website and database, and setup of computer models.

- A total of five integrity tests were conducted during the migration process. These integrity tests include:
- A step-by-step guide to walk through the configuration of a full OFoot scenario from scratch to ensure the user interface functions correctly

- A step-by-step guide to ensure user-specific features function correctly, such as the creation of a new user, resetting passwords for login, editing user profiles
- An OFoot scenario to test aspects of the biophysical model, the tool's orchestration of the model, and communication between the model, the website, and the database
- An OFoot scenario to test the interaction between outputs of the biophysical model and carbon footprint model
- An OFoot full scenario that requires nearly all components of the tool that will be compute intensive

To test performance, three identical OFoot scenarios were run on both servers to compare runtime. One scenario consisted of numerous components to be resource intensive. A second test consisted of two scenarios running sequentially, to test the handing off of one scenario to the next.

Results

The migration resulted in the upgrade of software infrastructure needed to run the tool. The server operating system was upgraded from Microsoft Server 2012 to Microsoft Server 2016, the server software was upgraded from Internet Information Services 7 to Internet Information Services 10, and from Microsoft SQL Server Manager 2005 to Microsoft SQL Server Manager 18.4.

The five integrity tests were conducted iteratively throughout the migration process to uncover issues with server configuration, website/database setup, and installation of the computer models. By the end of the project, all integrity tests passed without issue.

The scenario runtime of the new host was less performant than the old host. The resource-intensive scenario took 24 minutes to complete on the new host and 17 minutes on the old host. The sequential scenarios took 27 minutes on the new host and 19 minutes on the old host.

Discussion

The migration resulted in a significantly more secure hosting environment with better accessibility for continued development. The virtual machine is maintained by CAHNRS IT so is being monitored for malicious traffic, has established firewall rules, and weekly backups in case of system failure. The upgraded software infrastructure results in more robust tools, with fewer exploits and longer continuous support from vendors. Finally, CAHNRS IT provides technical support, which was not available with the old host.

The integrity tests all passed, but issues with small edge cases likely exist. Another benefit with the new host is that accessing the VM is much faster than accessing the old host, which reduces the time it takes to troubleshoot issues and fix them.

The reduced performance of the tool on the new host is unfortunate, but not unexpected. As described in the cost-benefit document, the chosen VM instance had potentially worse performance than the physical, "on prem", option. This is not an issue, however, as users are notified by email when their run is complete. Another benefit of a VM is that they easily scale vertically, meaning more virtual resources can be appropriated as the need arises. As demand increases for the tool, CAHNRS IT could increase the computing power of the server (at an increased expense).

Publications, Handouts, Other Text & Web Products:

The OFoot carbon footprint tool is available online for free at: https://ofoot.cafltar.org

Outreach & Education Activities:

Impacts

Short-Term:

The cost-benefit analysis has helped guide decisions about the infrastructure required for long-term OFoot hosting, as well as other environmental data collection, storage, and analysis. The migration of the OFoot tool to a new host has created a more secure environment and better accessibility for current use, debugging, and continued development.

Intermediate-Term:

With expanded use of OFoot, farms will identify and tackle hotspots in their greenhouse gas production, reducing agricultural carbon footprints. With the tool's increased accessibility for developers, OFoot can be more easily enhanced to support novel research initiatives. Grazing can be integrated into the model allowing studies on mixed crop-livestock farming. Additionally, the geographical reach of the tool can be easily expanded allowing greater comparisons between more diverse farming systems across the nation.

Long-Term:

The long-term life of the tool, with continued development and research output, will result in a mature and trusted partial life-cycle assessment model. The tool may be adopted by policy makers interested in carbon credits or other sustainable initiatives. Organic certifiers my adopt the tool to aid in the certification process.

Additional funding applied for/secured:

Now that the OFoot tool is stable, The USDA-ARS Northwest Sustainable Agroecosystems Research unit will support the tool using long-term guaranteed funds from the USDA-ARS funded program, the Long-Term Agroecological Research (LTAR) network. The LTAR network will support functionality of the tool for at least five years, given federal funding for the LTAR Palouse location. The tool will play a role in continued competitive funding requests in 2020 and beyond.

Graduate students funded: None

Recommendations for future research:

The USDA-funded Long-Term Agroecological Research (LTAR) network has a focus on understanding how various methods of sustainable intensification of our farming systems impacts the environment, productivity, and rural prosperity. To measure such effects, the network has adopted ecosystem services to act as metrics and thus has become interested in life cycle assessment tools. OFoot can be used to conduct a nation-wide analysis to compare business as usual management practices with aspirational ones. To serve farm operations that use synthetic fertilizers and pesticides, OFoot will require updates to include these inputs. To serve farm operations outside the Pacific Northwest, OFoot will require an update to expand the climate data available to it.