

# Growing in the Cloud: Modern Nursery Data Management Systems

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## Abstract

Today's modern telecommunication and Internet technologies have come a long way to help decrease the amount of paper-work and make information easier to use. Phones are becoming small handheld computers capable of so much more than just a simple phone call. Smart phones have apps for calendar, social media, business functions, and much more. This technology can be used to simplify or improve nursery operations. This article gives an introduction to a few beneficial cloud-based technologies that can make nursery management a little easier, optimize time, provide useful real-time information, and minimize data input and associated errors. This paper was presented at a joint meeting of the Western Forest and Conservation Nursery Association, the Intermountain Container Seedling Growers Association, and the Intertribal Nursery Council (Boise, ID, September 9–11, 2014).

## What Is the Cloud and How Can Nurseries Use It?

In the simplest terms, cloud computing means storing and accessing data and programs using the Internet instead of a computer's hard drive. Internet storage eliminates the need to rely on one computer or device. Depending on the cloud service used and how it is configured, information could be available everywhere Internet access is available, and, in some cases, even where Internet access is unavailable. A cloud-based version of most computer-based applications and software can be used on any computer or handheld device. For example, Microsoft® Office is now in the cloud and has the same functionality of Microsoft® Office on any computer or device almost everywhere. One can simply log onto the Web site or open the app on a handheld device and be able to use the programs as needed. The cloud can be used for sales and invoicing, inventory, databases, data storage, e-mail, software, and more. Because many options are available for using technology to improve information flow, it can be difficult to determine which technologies are best suited for a given nursery. Examples of a few cloud-based technologies that can greatly improve nursery functionality and work flow are described in this article.

## Syncing Information Across Devices

Several applications make it easy to share data among computers and devices so the most current version of a file is always available to each computer that has access to it. Cloud-based storage options such as Google Drive and Dropbox provide access to files from any device with an Internet connection at a very low cost (table 1). These applications also have options for downloading files for use when not connected to the Internet. By simply downloading the application from its Web site and following the setup instructions, the program will then run in the background and constantly update files as they are changed on any computer or handheld device linked to it. It may seem simple, but these programs are very powerful in their application by allowing access to files, regardless of where one is and what device is in use, and by syncing automatically among computers, phones, and other devices. This system has the added benefit of a real-time backup of all files on a remote, secure server thereby eliminating the need to keep physical data backups. When installing the applications on mobile devices, the files can be physically downloaded to that device, taken into the field for data collection, and then automatically uploaded to all other devices. This ease of access is especially useful for field inventories in locations where Internet connections may not be reliable. Many companies today offer cloud storage, and each program has unique options. Some programs also offer business plans that enable you to control access to specific files and folders.

**Table 1.** Sample of cloud-based storage options currently available.

Product	Free storage	Price/100 GB/year (2015 U.S. dollars)*	URL
Google Drive	15	23.99	<a href="http://www.googledrive.com">http://www.googledrive.com</a>
Dropbox™	2	11.99	<a href="http://www.dropbox.com">http://www.dropbox.com</a>
Box	5	40.00	<a href="http://www.box.com">http://www.box.com</a>
SugarSync®	5	74.99	<a href="http://www.sugarsync.com">http://www.sugarsync.com</a>
MicrosoftOneDrive	7	23.99	<a href="http://www.onedrive.com">http://www.onedrive.com</a>
Apple iCloud	5	23.99	<a href="http://www.icloud.com">http://www.icloud.com</a>

GB = gigabyte.

\*Price is prorated if 100-GB plan is not offered.

## Cloud-Based Databases

Most nursery offices have piles of handwritten paperwork with information on seed, sowing dates and locations, culturing, transplanting, packing, shipping, etc., which require someone to manually input that information into a database so it can be used in some manner. These piles of paperwork often get piled according to their importance, and less important paperwork may sit for a very long time before being entered into a computer database. Some paperwork may never get input into a system, because the time required to enter it outweighs the benefit of the information. During busy seasons when other aspects of nursery management require attention, paperwork can go by the wayside. Nurseries can benefit greatly by eliminating paperwork and spending less time entering the information into a mobile device than was previously spent writing it by hand.

Some database programs available today mimic commonly used programs such as Microsoft Excel® or Microsoft Access™, thereby minimizing the transition period and learning curve necessary to use them. With these databases, existing Excel documents can be uploaded to the program's Web site so that important information is available when the new database system is put into operation. When crops are tracked with a unique number or identifier, new information about the crop can be linked to that identifier so existing information does not have to be reentered. This ability to link data is called a relational database and is something to consider when looking at all the databases offered. If linking different tables and information across a database is desired, then a relational database is a must.

After researching a few options, we chose TrackVia (<http://www.trackvia.com>, Denver, CO) for use at IFA Nurseries (which grew out of the old Industrial Forestry Association) in Canby, OR. TrackVia is an online database that offers a mobile interface and full access on both desktop and mobile devices. It is described as a “do-it-yourself workflow software platform for business users.” The following sections describe a few nursery operations in which this technology has been applied at IFA Nurseries to assist with information collection and data flow.

## Cultural Practices

Nursery cultural practices are anything done to the crop during its growth cycle. Culturing includes fertilizer and chemical applications, pest management, root pruning, quality testing, etc. Using cloud-based databases has been a huge help in information flow and recordkeeping and has significantly improved our overall efficiency.

We have one master table with a list of every chemical we use, along with rates, U.S. Environmental Protection Agency numbers, reentry intervals, necessary personal protective equipment, chemical classes, etc. (figure 1). As we walk through the crop to determine pest management needs, we can simply add a new chemical application (or cultural practice) to the task list and let our operators know a new chemical application or culturing practice has been posted (figure 2). The tasks are ordered by importance and the operators simply access the database on their mobile device and select each task to get all the information they need to properly apply the chemical or cultural treatment (figure 3). After the application is complete, the operators input when and where they applied

Product	Active ingredient	REI	EPA number	Rate	Application rate	Target pest	Water	Comments (Cmby)
S-Fenvalate Star	Esfenvalerate and benzethiazole	12	71532-21-73006	8oz/100gal	100gal/acre	Lygus	No	When using Tri-Fol buffering agent 3-4oz per 200gal has been sufficient to get optimum pH of 6.5. Make sure not to use more than 10 applications per year, or other chemicals containing pyrethroids. Do not use over 17oz a year. Lygus 8oz/acre recommended. Not recommended to use spreaders or stickers since absorption by plant is ideal.
Flagship 25WG	Thiamethoxam	12	100-955	8oz	100gal/acre	Lygus	no	only 3 applications per year. Optimal pH of 6.5
Warrior II	Lambda-cyhalothrin (Systemic)	24	100-1295	1.3-2.5oz	50gal/acre	Lygus	no	When using Tri-Fol buffering agent 5-5pH is recommended
Orthene	Acephate	24	59639-26-AA	2/9lbs(10.5oz)	100gal/acre	Lygus	no	When using Tri-Fol buffering agent 5-5pH is recommended
Asana	Esfenvalerate	12	352-515	8oz/100gal	100gal/acre	Lygus	no	When using Tri-Fol buffering agent 3-4oz per 200gal has been sufficient to get optimum pH of 6.5. Make sure not to use more than 10 applications per year, or other chemicals containing pyrethroids no more than 6 lbs active ingredient a year 5.5pH
Acephate 97UP	Acephate	24	70005-0	0.5lbs/100gal	100gal/acre	Lygus	no	When using Tri-Fol buffering agent 5-5pH is recommended
Pennant Magnum	S-metolachlor	24	100-380	2-2.5pts/acre	40gal/acre	Nut Sedge, weeds	40gal	preemerg mix with goal tender, does not work well once nutsedge is up. Mixes with glyphosphate, atrazine, and goal must wash off plants if applied over for at least 30-45min. DO NOT apply more than 5.2pts a year.
Detonate	Diglycylamine salt	24	7969-137-55467	8-32oz	40 gal/acre	Broad Leaf Weeds	no	
Goal Tender	Oxyfluorfen	72	62719-447	1/2-2 pint	40gal/acre	small weeds and preemergence of weeds		DO NOT apply more than 2lbs of active ingredient per year (4pts) With Proper PPE people can enter before REI is finished
Glystar	Glyphosate	12	42750-61	2qt/40gal	40 gal/acre	Broad leaf and grass		
Envoy Plus	Glethodim	24	59639-132	12-32oz	40 gal/acre	Grasses	no	
Endurance	Prediamine	12	100-834	1lb/acre	50gal/acre	Broad leaf and grass	yes 1/2in	Tank mix goal
Ablicon 4L	Atrazine	12	9779-255	4qt/40gal	50 gal/acre	Broad leaf and grass		

Figure 1. A cloud-based, detailed chemical information table is used to give specific information about nursery chemicals, such as rates, proper usage, target pest(s), and U.S. Environmental Protection Agency numbers.



the treatment(s) and the amount of any chemicals they used. This system has enabled us to efficiently keep track of our chemical usage and have a running list of everything we have applied or have done to a given crop at the click of a button. Now, when we are out in the field with customers and they ask what has been done to their crop, we can immediately access a list of dates and activities for their crop on a mobile device. Also, when it is time to order more chemicals or fertilizers, the database provides an inventory of exactly how much chemical has been used in the past, thereby enabling us to accurately estimate future needs.

**Figure 2.** An equipment operator looking up fertilizer recommendations on his mobile device to see product and rate information and application location. (Photo by Mike Taylor, 2015)

## Cultural Practices (Applicator Form)

**Applicator Entry**

Application Date

Product 1 Used

Product 2 Used

Water Used

Applicator Comments

Applicator

Jesse  Sam  Craig  
 Barry  Russ  Thomas  
 Mike  Chris  Farrell  
 Collin  Jermie  Alfredo  
 Ben

# Days To Complete

1  2  3  
 4  5  6  
 7  8  9  
 10  11  12  
 13  14  As Completed

**Location**

Blk <input type="text" value="2"/>	Total Footage <input type="text" value="252800"/>	Crop
Beds <input type="text" value="22-180"/>	Acres <input type="text" value="5.803"/>	<input type="checkbox"/> 1114 <input type="checkbox"/> 4413 <input type="checkbox"/> 4414 <input type="checkbox"/> FP14 <input type="checkbox"/> F114 <input type="checkbox"/> SP14 <input type="checkbox"/> FP15 <input type="checkbox"/> 1115 <input type="checkbox"/> SP15 <input type="checkbox"/> FP16 <input type="checkbox"/> F116 <input type="checkbox"/> 1116 <input type="checkbox"/> Allocated

**Prescription**

Creation Date <input type="text" value="Tue Sep 9, 2014 11:23 AM PDT"/>	Water Per Acre <input type="text" value="100gal"/>	Treat
Product 1 <input type="text" value="Acephate 97UP"/>	Product 2 <input type="text" value="Tri-Fol"/>	<input type="checkbox"/> Paths <input type="checkbox"/> Bed Ends <input checked="" type="checkbox"/> Trees <input type="checkbox"/> Whole Field
Product 1 Per Acre <input type="text" value="0.5lbs"/>	Product 2 Per Acre <input type="text" value="5.5pH"/>	

**Figure 3.** A sample cloud-based cultural practices form that applicators at IFA Nurseries use when applying chemicals.

## Lifting and Packing

Another area of our operation in which using TrackVia has increased efficiency and decreased paperwork is lifting and packing operations. Lifting and packing season is the busiest season we have, because all the stock will be lifted and shipped or stored during a few short months. It is also the season when the ability to stay abreast of paperwork is at its worst. In the past, we would print a list of beds or crops we wanted to lift that day and hand it to our lifting operator. The operator would then fill out the information such as the number of workers, start times, stop times, beds, etc. At the end of the day, the operator would give the paperwork to someone in the office who would then enter it into a computer-based Microsoft Excel® or Microsoft Access™ database. Since introducing TrackVia, the operators have been carrying mobile tablets on which they can access real-time information about each nursery bed and the lifting schedule priorities. As the operators complete the work, they enter the date and time, comments, number of lifters, and other details. The database then automatically calculates the labor production as the operator enters the information. This system also enables the manager to easily change the scheduling priorities based on conditions or needs; these changes show up immediately in the operators' tablets.

Another useful piece of information we are tracking in the cloud is cull data. In the past, all cull data was input on the back of the packing forms and never input into any database because the volume of information was too much and we rarely used the information. Now, as the packing line leaders do their quality checks in the packing shed, they enter the lot number and its corresponding cull data. The cull data is displayed graphically in real time as the information is being collected. This feature has provided a unique retrospective examination of our crop types to gauge the quality of each so we can improve in subsequent seasons.

Shipping and receiving information has also been very useful to keep in TrackVia. It enables us to link current pack production and volume to a specific customer. After the information is linked, we can bring up a specific customer's name and see every lot that the customer has in the cooler or freezer and lots that have not yet been lifted. This approach enables us to readily see the total lots packed and shipped and to determine the balance remaining for each customer.

By tracking all this information in the cloud, we have a powerful database for real-time tracking of crop information, as well as for following the progression of seedling lots over multiple

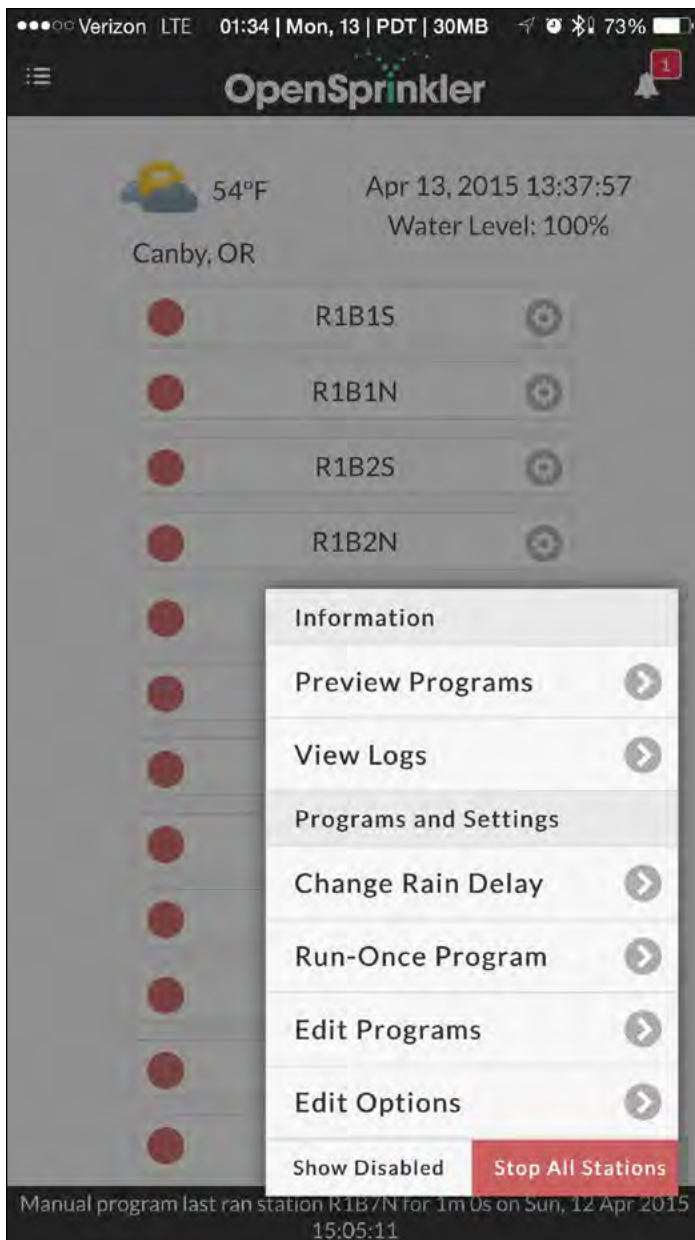
years. In addition to recording data, we can add “dashboards” within the program to build graphs to summarize information across tables. These graphs update as we input information. For each season, we create graphs for transplant production, packing production, sowing, etc., to gauge efficiency. With all the information in one place, we are able to keep track of daily production and the production among crews.

## Cloud-Based Control Systems

Irrigation scheduling at our greenhouse is a full-time job. In the past, irrigators had to do a lot of walking through the crop and then walking back to a computer to schedule the irrigation. Now, irrigators have a tablet or smartphone that can turn on and set irrigation schedules as they walk around the greenhouse (figure 4). In addition, we are able to control irrigation applications using a cloud-based system. Opensprinkler (Rayshobby Shop, Amherst, MA, at <http://www.rayshobby.net>) is a Wi-Fi based irrigation controller that uses an app on a mobile device or Web site to set irrigation schedules and run programs (figure 5). It enables anyone with Wi-Fi or Internet access to instantly turn sprinklers on and off. The program includes the ability to input restrictions to prevent turning on more irrigation lines than the pump can support. Irrigation zones can be prioritized and put into a queue; the system will turn on the next irrigation zone when the current zone finishes. It has been a very valuable time saver and solved a lot of logistical and timing issues. The system is easy to set up and very inexpensive compared with a computer-based system and integrates easily with handheld devices and computers.



**Figure 4.** Scheduling irrigation inside one of the greenhouses using a mobile device. (Photo by Mike Taylor, 2015)



**Figure 5.** Open Sprinkler is a cloud-based system for controlling irrigation. This screenshot shows basic irrigation scheduling options in the system's mobile app.

## Considerations for Selecting a Cloud-Based Database

It is important to consider a few things before starting to use a cloud-based system. First, not everything is most efficient when directly input into the cloud. As mentioned previously, we download our inventory files to our tablets for input during the day and then upload them back to the cloud at the end of the day. Cellular and Wi-Fi connections, however, are not always the best choice when constantly updating a file in the field. Even though we have great mobile service in our fields, it does not always have a good connection to the site and data can be lost if we are not careful. This system can also be a big drain on phone batteries using a cellular connection, but using a physical file on a tablet does not use nearly as much. Second, it may not be desirable to directly enter everything into the database. For instance, we decided to have pack volume and production entered into the database directly by the line leaders in the packing shed, but we chose to enter actual volume packed later, after we double check the numbers. An accurate pack volume is worth the extra data entry compared with troubleshooting errors at a later time. Third, and last, it will take time to develop cloud-based applications to be useful and efficient for a given operation. We started out in the summer by adding cultural practices, and then before every season, we added more functionality and made adjustments as we went along. Upon initial use, the system may not be exactly as desired, but with trial and error and input from others who use it, it will become more efficient and easier to use over time.

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