



THE OHIO STATE UNIVERSITY

Integration of Management Tools for Controlled Environment Research Facilities

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Greenhouse > \$250.00+ per sq. ft. (USD)
Growth Chamber > \$2500.00+ per sq. ft. (USD)



“We are **not able to optimize** our capacity “



CE Research Facility Management Challenges



“If something happened to me, it would **not very straightforward** for someone to pick-up what I do from a data management standpoint.”

“We spend **too much time managing information** and not enough time ensuring quality control.”

“The way our current system works, I could be sitting at my desk all day **clicking through endless pages** just to update everything that happens on a daily basis.”

 Survey sent to 62 CE Facility Staff 35 respondents = 56% response rate



How widespread is the data management challenge?





➤ **Identify data management obstacles**

- Time commitment, tech skills
- Quantity of data overwhelming
- How/where to store data
- Information communication

➤ **Identify negative impacts**

- Takes valuable time away from other tasks
- Inefficiencies/ Redundancy
- Data loss
- Cannot optimize high value research space

➤ **Evaluation of commonly used tools**

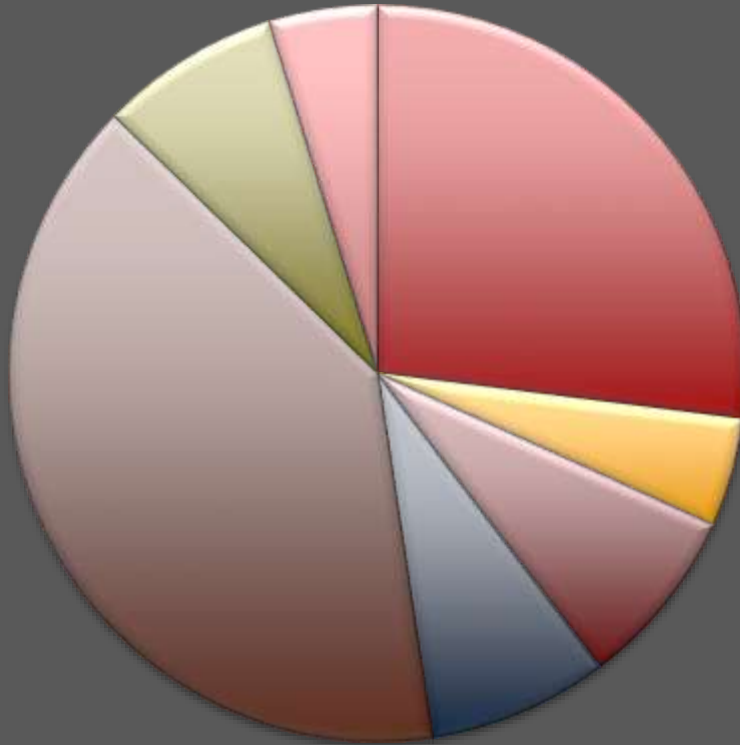
- Struggle creating custom solution
- Disorganized
- Requires manual cross-referencing
- Duplication of data sets for multiple functions



- ◆ There is a need to develop a solution for CE Research Facilities



Current Data Management Tools



- Spreadsheet
- Database
- Word Processor
- Hand Written
- Combination
- Adapted Software
- Brain



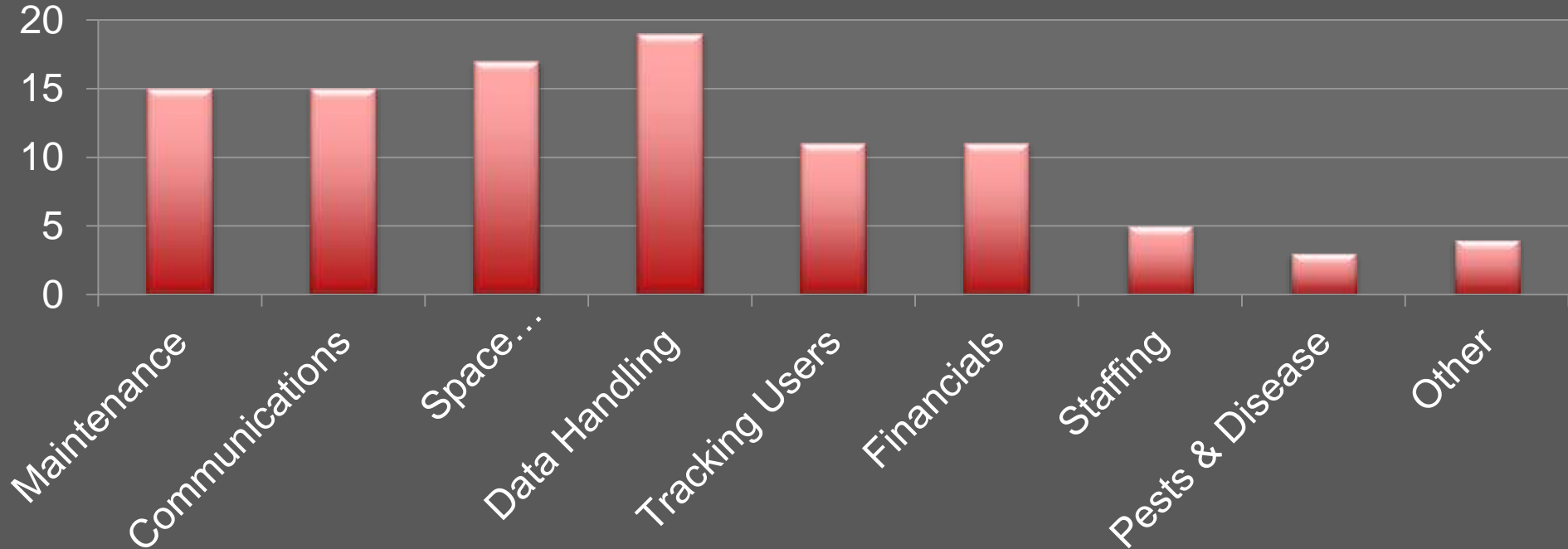
“We have a **patchwork of paper in binders** and basic software tools (spreadsheets mostly).”

“Space use is **mostly in my head** - if I'm gone it would be hard for someone else to know what material goes where and when.”

“most requests have to be **processed directly and manually** through the greenhouse manager”



Most Common CE Research Facility Management Challenges





What data to capture?

Amount of space

Length of project

Type of space

Environment Set Points
(Temp/RH)

Environment Readings

Light intensity/daylength

Quantity/size of pots

Potting mixes

Fertilizer types

Fertilization frequency/rate

Irrigation frequency/rate

GMO Handling/Tracking

Pest counts

Pest types

Disease infections

Notifications/Reminders

Best Practices

Pest control applications

Pesticide labels/MSDS

Chemical classes

Regulatory agency compliance

WPS central posting info

WPS training records

GMO labeling

Inventory (materials, chemicals,
equipment, plants)

Budgeting

Invoicing/Financials

Fee Structure

Planned maintenance

Equipment repair reports

Equipment manuals/schematics

Equipment make/model #

Materials sourcing contacts

Order of Entry



Schedules

Amenities

Genus/species/line

Facility users

Contact information

Lab/Team associations

Project archive

Standard Operating Procedures

Maps/ Floor plans



Desired Data Management Tools



- Pest Management
- Maintenance
- Space Management
- User Tracking
- Compliance Records
- Maps
- Environmental Data
- Financials
- Inventory
- Labeling



Development Goals for CE Research Facility Management Tool



Centralized

All under 1 roof



Accessible

24/7/365



Secure

password protect
data back up



Integrated

connect data



Real Time

up to date data



Network

APIs, smart GH



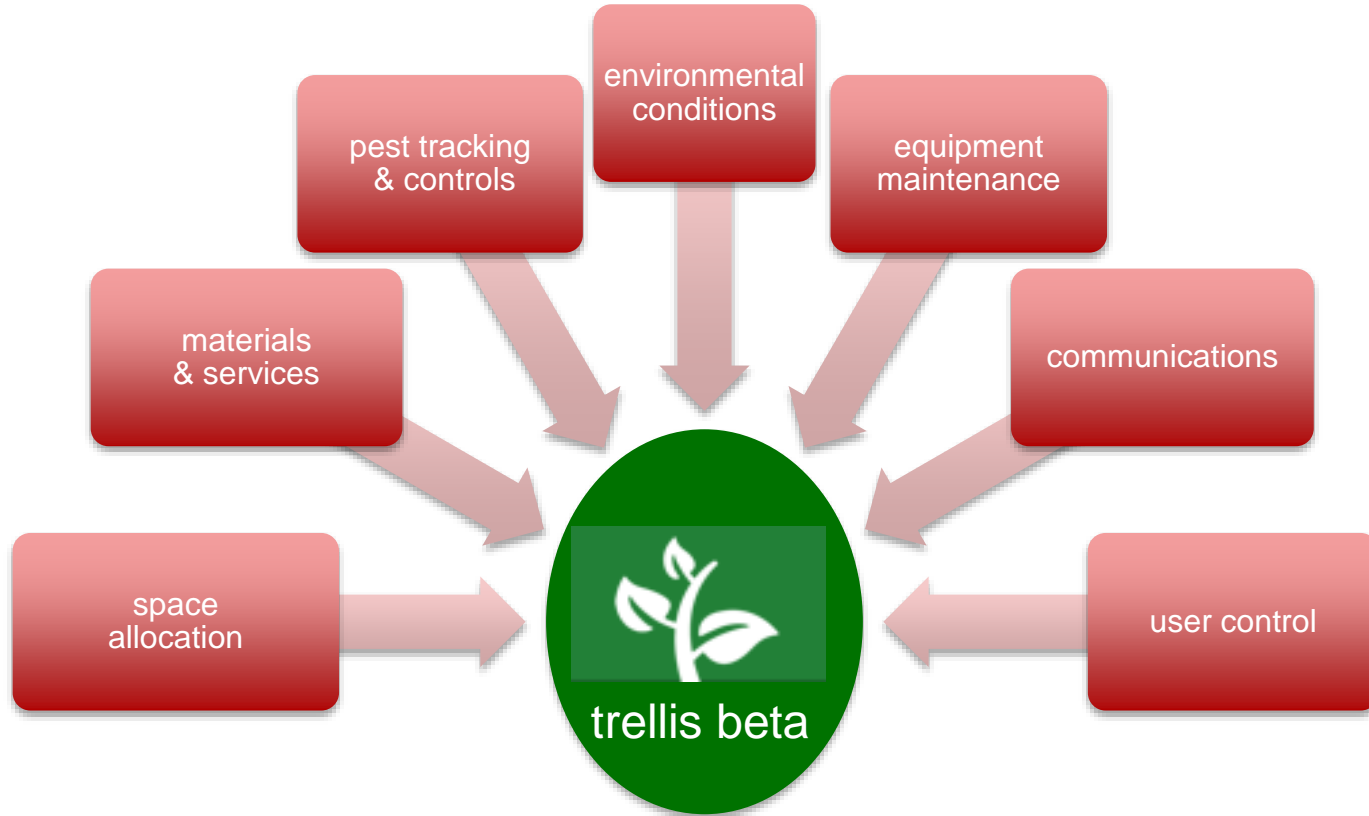
Customizable

build to suit



Easy to Use

“I’m **looking for a central clearinghouse** for all of the aspects of plant research facility management”





Space Allocation/Request Services & Materials

Search by date

Filter by type, configuration, amenities



Biological Sciences Greenhouse

August 9th, 2016 - September 23rd, 2016

Types

- Greenhouse
- Growth Chamber
- Outdoor
- Materials & Services ONLY

Configurations

- Long Day Arabidopsis
 - Humidity
50% - 50%
 - Light
18 light / 6 dark (150 µmol)
 - Temperature
21°C - 23°C
- Short Day Arabidopsis
 - Humidity
50% - 50%
 - Light



750K

0% - 0% 10°C - 30°C
336 sq/ft Available

Reserve



750E

0% - 0% 10°C - 30°C
120 sq/ft Available

Services

Irrigation

- Distilled Water Only
- Water On Weekends
- Keep Moist
- No Overhead Watering
- Keep Leaves Dry
- Do Not Water
- Let Dry Between Waterings

Fertigation

- No Fertilizer Water
- 15-5-15 Cal Mag Fertilizer
- 20-10-20 Fertilizer

Pest Management

- Use Beneficial Insects
- No Beneficial Insects
- Pesticide Use Permitted
- Do Not Apply Insecticides
- Do Not Apply Fungicides

Materials

* Type

1 gallon nursery

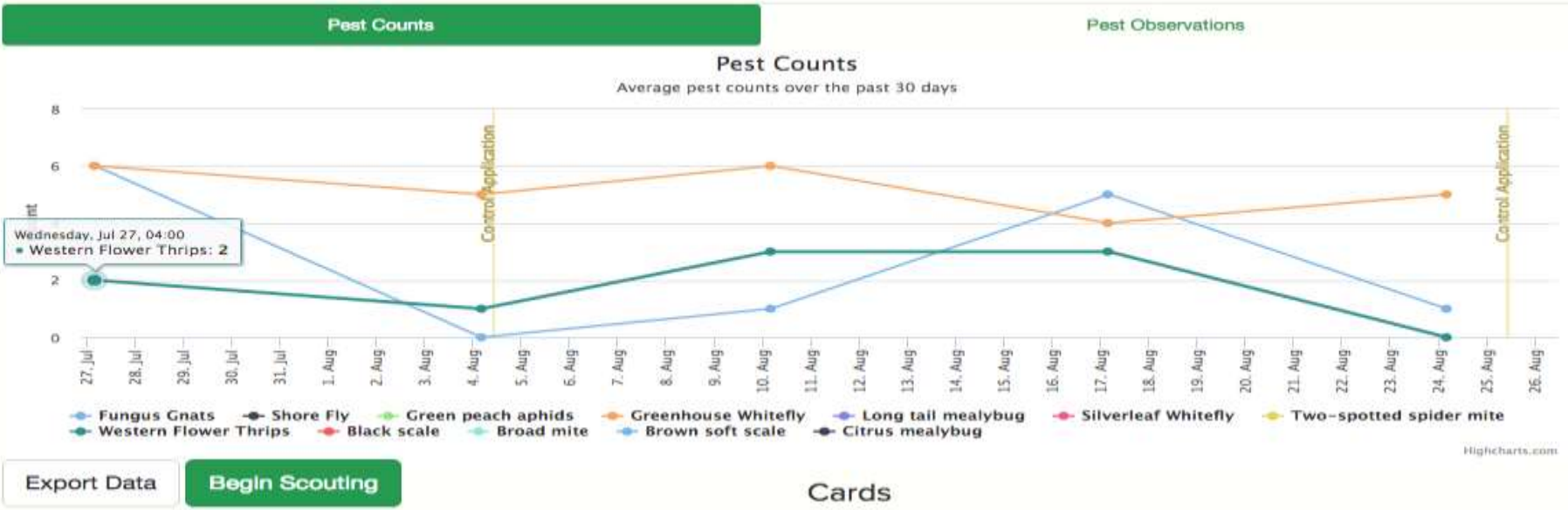
* Quantity

35



Pest Tracking

“There is **no link** between the pesticide treatments we do and the pest population **except in my head.**”



Cards



Pest Control Applications US EPA Compliance

Start	Finish	Target Pests	Crops	Location(s)	Location(s) Description	Treated Area	Control	Active Ingredient	EPA #
August 25th, 2016 10:00	August 25th, 2016 10:00	Greenhouse Whitefly	Marestail, Assorted Tropicals	750 Greenhouses - 750K 710 Greenhouses - 710C 710 Greenhouses - 710A/Waller Family Greenhouse 710 Greenhouses - 710D 710 Greenhouses - 710B	Greenhouse	2614 sq/ft	Encarsia formosa	N/A	N/A
August 17th, 2016 00:00	August 17th, 2016 00:00	Greenhouse Whitefly, Long tail mealybug, Western Flower Thrips, Citrus mealybug		750 Greenhouses - 750G	Greenhouse	30 pots	Marathon	Imidacloprid	59807-15
August 11th, 2016 07:00	August 11th, 2016 09:00	Western Flower Thrips	Medicago truncatula, SINE1-1 Mutant, WIT Double Mutant, Arabidopsis GFP/RFP lines, N. benthamiana WT, Assorted Tropicals	Aronoff Lab - 539A Common Aronoff Lab - 535 Meier Lab Use Only Bio Sci Growth Chambers - 718-Biotkin Lab Use Only 710 Greenhouses - 710C 710 Greenhouses - 710A/Waller Family Greenhouse 710 Greenhouses - 710H	Growth Chamber, Greenhouse	1763 sq/ft	Marathon	Imidacloprid	59807-15

Control Class	Formulation	Amount	Rate	Method	Equipment	REI Duration	REI Expiration	Applicator	Document(s)
N/A	N/A	1000	1K/1000 sq.ft	hang_card		N/A	August 25th, 2016 10:00	Joan Leonard	
4A Neonicotinoids	N/A	11.5 teaspoon	per pot	soil_top_dress	Measuring cup, Measuring spoon	12 hours	August 17th, 2016 12:00	Emily Yoders-Horn	<ul style="list-style-type: none"> Material Safety Data Sheet Label
4A Neonicotinoids	N/A	1.5 cup	1.5 cup/sq.ft	sachet		12 hours	August 11th, 2016 21:00	Joan Leonard	<ul style="list-style-type: none"> Material Safety Data Sheet



Environmental Settings/Data

Configurations

Add New

Search...

Name	State	Temperature	Humidity	Light	
Long Day Arabidopsis	Approved	21°C - 23°C	50% - 50%	18 light / 6 dark (150 µmol)	Edit
Short Day Arabidopsis	Approved	21°C - 23°C	50% - 50%	12 light / 12 dark (150 µmol)	Edit
Corn	Approved	22°C - 26°C	30% - 60%	16 light / 8 dark (1500 µmol)	Edit
Tropical	Approved	18°C - 24°C	25% - 70%	14 light / 10 dark (200 µmol)	Edit
Medicago	Approved	20°C - 23°C	25% - 60%	16 light / 8 dark (500 µmol)	Edit
Sarracenia	Approved	16°C - 30°C	35% - 95%	0 light / 24 dark (0 µmol)	Edit
Marestail	Approved	18°C - 25°C	30% - 70%	10 light / 14 dark (200 µmol)	Edit
Lettuce	Approved	18°C - 24°C	25% - 70%	14 light / 10 dark (200 µmol)	Edit
Cockroaches and Dermestids	Approved	23°C - 30°C	75% - 80%	0 light / 24 dark (0 µmol)	Edit
Erosion	Approved	23°C - 26°C	75% - 80%	0 light / 24 dark (0 µmol)	Edit

➤ Build API with controls to live stream environmental data



Maintenance

+ Maintenance Record

Maintenance Task List

Pending

Search...

Date	State	Priority	Scope	Growth Space	Equipment	
August 25th, 2016	Pending	Normal	relamp	720-Meier Lab Use Only	Fluorescent Lights	Actions ▾
July 12th, 2016	Pending	Normal	clean out tank	750A	Sump Tank	Actions ▾
June 20th, 2016	Pending	High	replace pump	750H	Swamp Coolers-Pump	Actions ▾
June 8th, 2016	Pending	Normal	Replace ballast/cap in fixture #4	750D	400W MH Lights	Actions ▾

➤ sort by growth space

Maintenance

Date	State	Priority	Scope	Growth Space	Equipment	
June 14th, 2016	Completed	Normal	preventative maintenance	722-Common	Biochamber GC-20	Actions ▾
June 2nd, 2016	Completed	Urgent	Check for electrical shorts	722-Common	Biochamber GC-20	Actions ▾



Communications & User Control

Facility Members

Add Facility Member

Export as CSV

Search...

User	Email	Role	State	Note	WPS Date	Address	Phone	Department	Labs	
Alecia Wagner	wagner.934@osu.edu	Member	Active		2015-08-25	4646 Moss Court columbus, Ohio 43214	6146322727	Molecular Genetics	Meier Lab	<input type="button" value="Edit"/> <input type="button" value="v"/>
Andrew Kirkpatrick	kirkpatrick.173@osu.edu	Member	Active			Aronoff Laboratory 318 W 12th Ave Columbus, OH 43210	203-313-4521	Molecular Genetics	Meier Lab	<input type="button" value="Edit"/> <input type="button" value="v"/>
Anna Griffin	griffin.33@buckeyemail.osu.edu	Member	Active		2017-08-21	516 Aronoff Laboratory 318 West 12th Ave. Columbus, Ohio 43210	7037256962	Molecular Genetics	Meier Lab	<input type="button" value="Edit"/> <input type="button" value="v"/>
Bryan Carstens	carstens.12@osu.edu	Member	Active			Aronoff Laboratory 41... Building	662-231-9557	Evolution, Ecology & Conservation		<input type="button" value="Edit"/> <input type="button" value="v"/>

Growth Space Notices

- 750B** Vent Repairs scheduled for Sep 16, 2016
- 750D** Pest Alert: Aphids in pansy crop. Please follow order of entry and wear a lab coat when working in this space.
- 710K** Waller Lecture reception Sep 22 2-4PM



Current & Future Development

- API environmental controls
- Beta tweaks – UI, labeling/RFID?, platform optimization
- Financials

- Inventory
- Data collection- API with phenotyping systems/smart GH hardware
- Energy consumption
- Analytics/Statistics/Recommend Actions
- Calendar
- Interactive GUI Maps
- Labor & task tracking
- Reports



Thank You

AgBiome
University of Alberta
Bayer Crop Science
University of California-Berkeley
University of Calgary
Canadian National Research Council
Central Michigan University
Colorado State University
Cornell University/ BTI
DuPont
University of Guelph
Harvard University
University of Illinois
Iowa State University
Kansas State University
McGill University
University of Minnesota
University of Nebraska-Lincoln
Noble Foundation
Oregon State University
Penn State University
Purdue University

Syngenta
Texas Tech University
University of Toronto
Washington University
University of Wisconsin- Madison
West Virginia University
University of Wyoming
Yale University



OSU Technology
Commercialization Office



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