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Case Study

Inari Agriculture

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A Flagship Pioneering Company

Case Study: Inari Agriculture

ESP to supports end to end automation for new seed development and test:

Created workflow management system that handles process flow and data provenance throughout their "High Throughput" Workflow for "biolistics" experiments on their maize and soybean crops. We automate data management in everything from experimental setup, Greenhouse transfers, pollination, harvesting, and reporting; all while providing an intuitive interface for barcode scanning (e.g. scanning plant samples into a 96-well block before sending it off for bioinformatic analysis), inventory management (e.g. for materials and media needed to operate the gene gun), and location management (tracking plant locations on benches in their greenhouses).
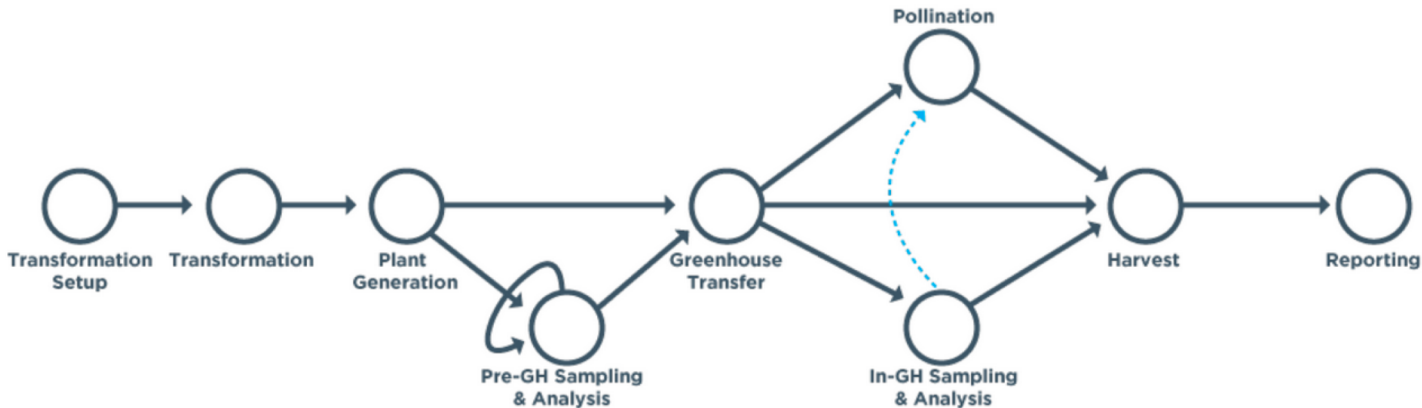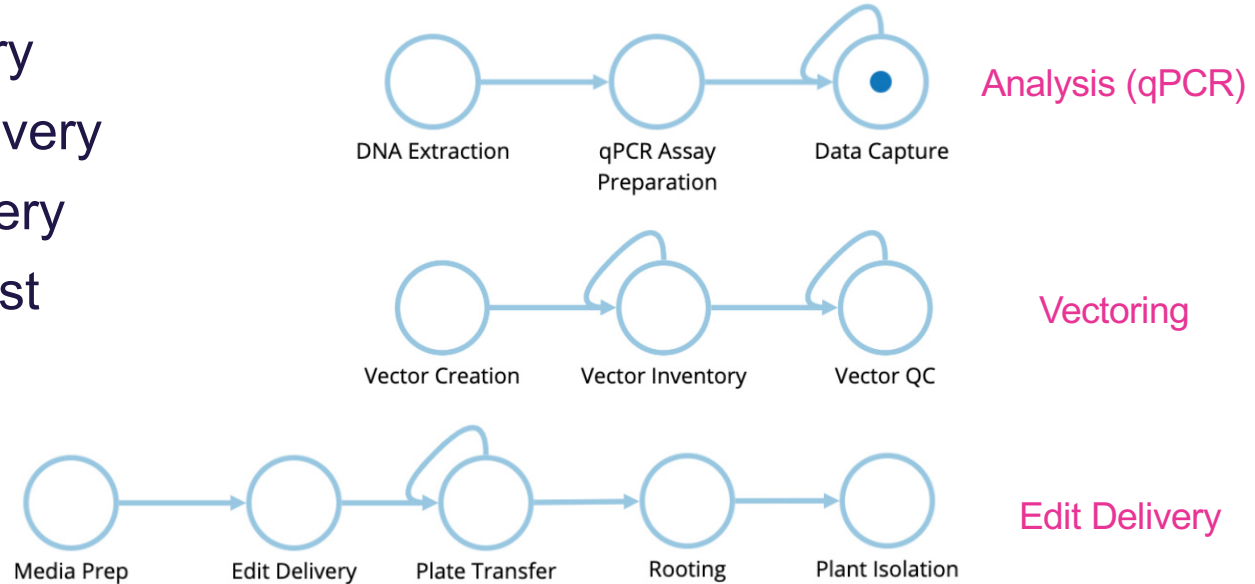
Project Scope

This project focused on implementing 8 ESP workflow chains for Inari West.

1. Maize Edit Delivery
2. Soybean Edit Delivery
3. Tomato Edit Delivery
4. Media Lab Request
5. Vectoring
6. Plant Sampling
7. Analysis

Analysis (qPCR)

DNA Extraction → qPCR Assay Preparation → Data Capture

Vectoring

Vector Creation → Vector Inventory → Vector QC

Edit Delivery

Media Prep → Edit Delivery → Plate Transfer → Rooting → Plant Isolation

Project Scope description

In these workflow chains, users at Inari were able to:

- Pull vector data from Benchling into ESP

- Perform experiment setup and define experiment parameters on which to perform maize edit deliveries

- Enter and track data associated with performing edit delivery experiments

- Generate unique identifiers and/or barcode labels for various entities throughout the experiment, including plants, explants, and treatments

- Perform sampling (by scanning plants into a 96-well plate) and "analysis" (run an automated pipeline to trigger a machine-recommended decision)

- Generate a Greenhouse transfer manifest and track location in the greenhouse

- Establish object hierarchy during pollination

ESP sample ancestry system

ESP sample ancestry system keeps track of the relationships between Ears (of corn), explants (a.k.a. embryos harvested from the ears), plants, child plants (as a product of pollination), to batches of seed.

Project management and bottle neck identification: ESP is the master controller of the project

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Experiments 9
View and manage all experiments by Workflow

+ New Experiment   + New Project   ▼ Filter Experiments

Advanced Filters Clear

☐ Hide Completed Experiments

Experiment Name
ex: ESP123

Status
Select Experiment-status

Project
ex: ESP Project

Workflow
ex: DNA Extraction

Owner
ex: ESP Admin

▦ By Project   💼 By Workflow   👤 By Owner   ☰ List

▼ **Workflow : Transformation Setup**   2 Experiments

Experiment Name	Status	Samples	Project	Owner	Last Activity	
ZM000002	Queued	4	Workflow Testing	system admin	Jun 21, 2019 (CDT)	⋮
ZM000001	Done	4	Workflow Testing	system admin	Jun 19, 2019 (CDT)	⋮

▼ **Workflow : Reporting**   1 Experiments

Experiment Name	Status	Samples	Project	Owner	Last Activity	
ZM000001	Queued	4	Workflow Testing	system admin	Jun 20, 2019 (CDT)	⋮

▼ **Workflow : Harvest**   1 Experiments

Experiment Name	Status	Samples	Project	Owner	Last Activity	
ZM000001	Done	4	Workflow Testing	system admin	Jun 20, 2019 (CDT)	⋮

▼ **Workflow : Pollinate**   1 Experiments

Experiment Name	Status	Samples	Project	Owner	Last Activity

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Integration to Benchling ELN to upload vectors created in the lab into ESP

Worksheet: ZM000002
Transformation Setup

Archive | Save | Save and Continue

< Prev | Vector Selection - (4) ⇕ | Next > | 1 of 3 Protocols | Pull from Benchling ◈ | ≡

Sample	* Vectors	* Ears	Total Number of Embryos	Notes	☐ Complete ≡
☐ TMT000004	pIN000001	EAR000004	400		☐
☐ TMT000003	pIN000002	EAR000003	250		☐
☐ TMT000002	pIN000003	EAR000002	370		☐
☐ TMT000001	pIN000004	EAR000001	340		☐

Columns

Protocol Details

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Efficiency report – assess plant viability after treating plants with vector or agrobacterium

Process automation: Automatic generation and emailing of plant manifests

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Inari Plant Transfer Manifest

Originating Location	Transfer Location
Inari-West	Inari-West GH1
Kurz Purdue Technology Center	3315 Kent Ave.
1281 Win Hentschel Blvd.	West Lafayette, IN 49706
Suite W1108	
West Lafayette, IN 49706	

Plant ID	Date of Transfer	Vector	Creator
MZINW000001	06/20/2019	pIN000001	system admin
MZINW000002	06/20/2019	pIN000001	system admin
MZINW000003	06/20/2019	pIN000001	system admin
MZINW000004	06/20/2019	pIN000001	system admin

Process automation: Automatic to signal ahead to the greenhouse what plants they will be receiving

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Results & Value

L7's ESP enables Inari to meet their goals for data and process management by providing an operations automation + collaboration platform

1. **ESP automatically:**
    - Tracks entity relationships (e.g. Plant → Seed)
    - Tracks locations of entities, whether in the lab or on the field
    - Validates and processes incoming data

2. **Ability to make quick changes to processes in LIMS**
3. **ESP provides many pieces of automation in the Inari Agriculture implementation. These include:**
    - Automatic label printing as the user progresses through their workflows
    - Calculations to aid in tracking explants
    - Integrations with lab equipment (e.g. sequencers, fluorimeters, liquid handlers)

ESP has served Inari Agriculture by managing data collection, accommodating technologies that are currently in use, and accelerating both new and existing processes.