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

Worksheet: ZM000002
Transformation Setup

<table>
<thead>
<tr>
<th>Sample</th>
<th>* Vectors</th>
<th>* Ears</th>
<th>Total Number of Embryos</th>
<th>Notes</th>
<th>Complete</th>
</tr>
</thead>
<tbody>
<tr>
<td>TMT000004</td>
<td>pIN000001</td>
<td>EAR000004</td>
<td>400</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TMT000003</td>
<td>pIN000002</td>
<td>EAR000003</td>
<td>250</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TMT000002</td>
<td>pIN000003</td>
<td>EAR000002</td>
<td>370</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TMT000001</td>
<td>pIN000004</td>
<td>EAR000001</td>
<td>340</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Efficiency report – assess plant viability after treating plants with vector or agrobacterium

<table>
<thead>
<tr>
<th>Sample</th>
<th># Explants</th>
<th># Plants Harvested</th>
<th>Efficiency (TE%)</th>
<th>Notes</th>
<th>Complete</th>
</tr>
</thead>
<tbody>
<tr>
<td>TMT000003</td>
<td>400</td>
<td>250</td>
<td>62%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TMT000002</td>
<td>350</td>
<td>300</td>
<td>85%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TMT000004</td>
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<td>160</td>
<td>64%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TMT000001</td>
<td>100</td>
<td>20</td>
<td>20%</td>
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</tbody>
</table>
Process automation: Automatic generation and emailing of plant manifests

Inari Plant Transfer Manifest

<table>
<thead>
<tr>
<th>Originating Location</th>
<th>Transfer Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inari-West</td>
<td>Inari-West GH1</td>
</tr>
<tr>
<td>Kurz Purdue Technology Center</td>
<td>3315 Kent Ave.</td>
</tr>
<tr>
<td>1281 Win Hentschel Blvd.</td>
<td>West Lafayette, IN 49706</td>
</tr>
<tr>
<td>Suite W110B</td>
<td></td>
</tr>
<tr>
<td>West Lafayette, IN 49706</td>
<td></td>
</tr>
</tbody>
</table>

**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
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.