



Economics of Indoor Agriculture Labor Efficiency

optimiauniversity.org

OptimIA Economics Team

Simone Valle de Souza, Ph.D.

H. Christopher Peterson, Ph.D.

Joseph Seong

&

Adeline Cohen, agr. , AU Lab, Canada

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A comparative analysis

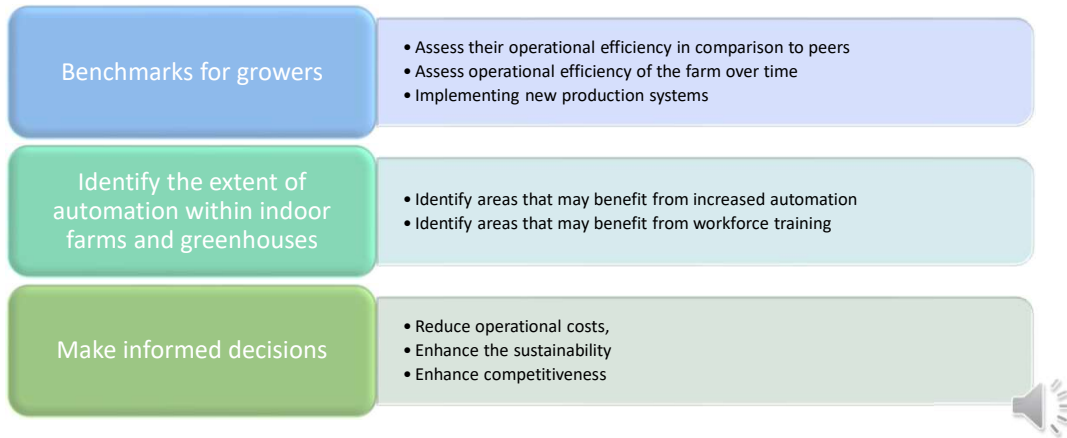
- Indexes of Labor Efficiency:
 - Production per labor hour (kg/h)
 - Productivity of labor (kg/\$)
 - Cost of labor per yield (\$/kg)

- Labor requirements in CEA
 - Labor and Automation
 - Workforce training needs



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Labor Efficiency Indexes



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Survey: Labor in Controlled Environment Agriculture (CEA)

Indoor Farms
Use vertical space
Sole-source lighting systems

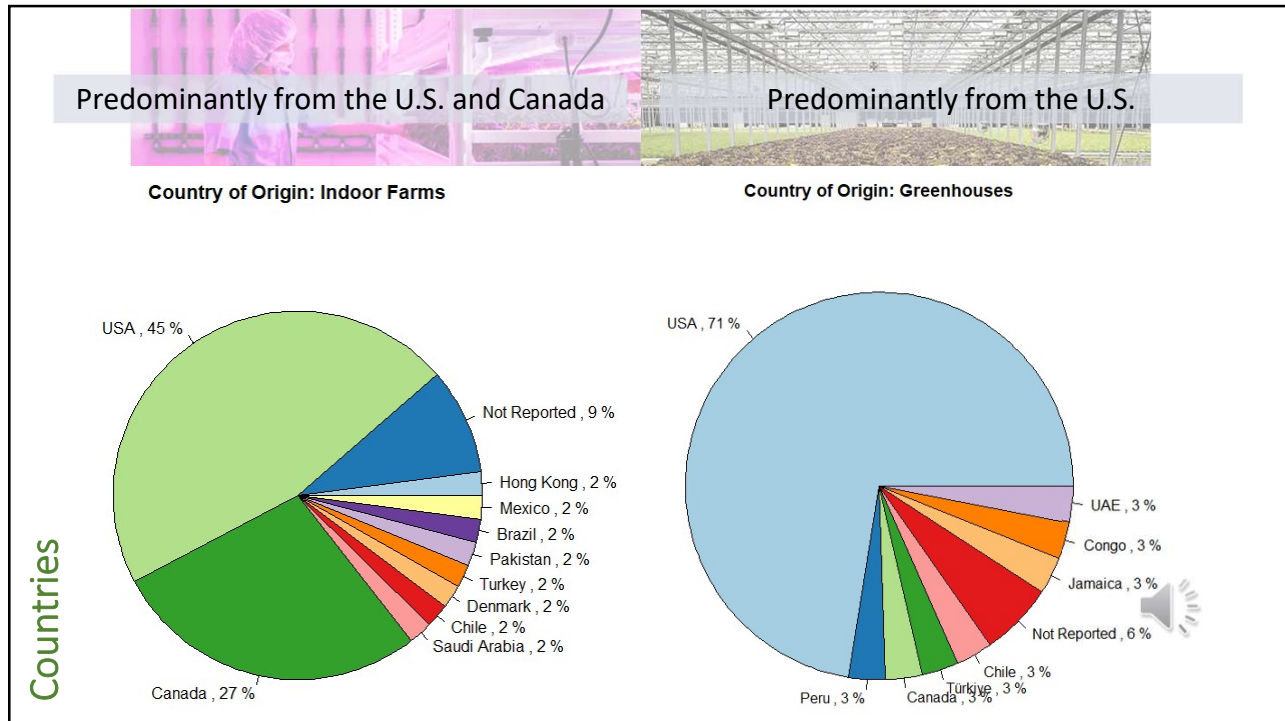
Greenhouses
One single level growing space
Predominant use of sunlight

Photo : PlantedDetroit

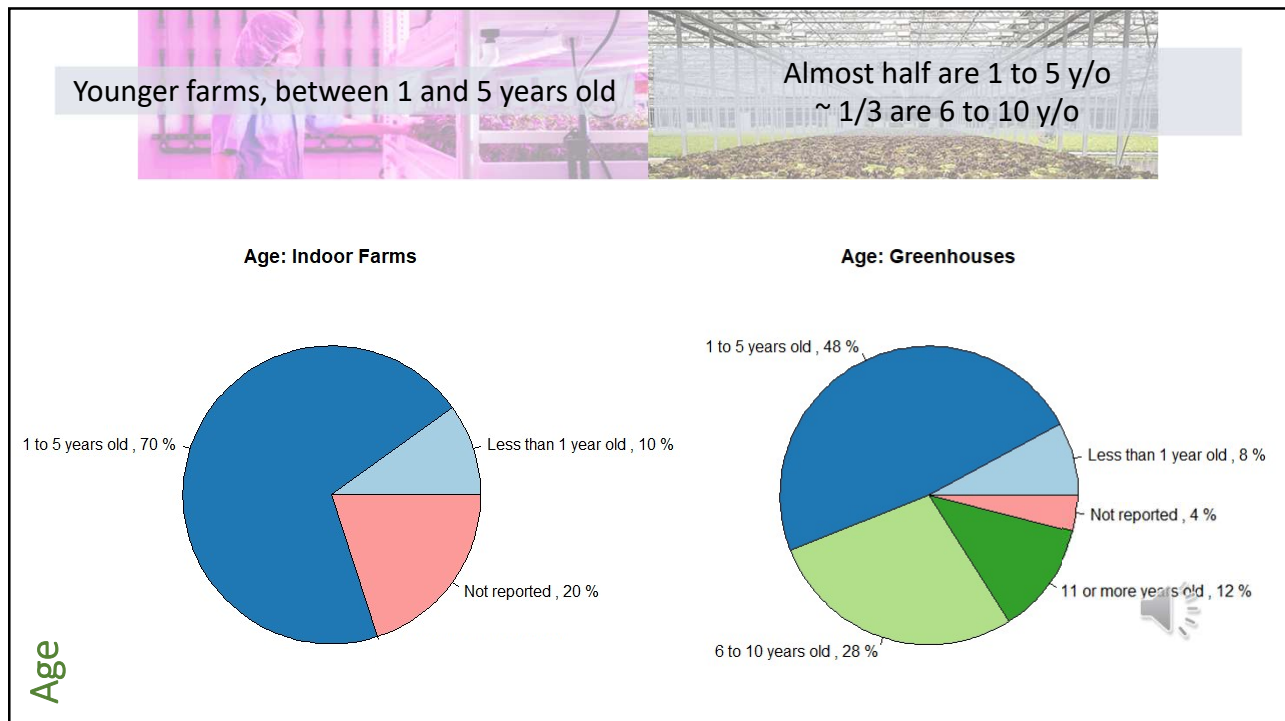
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Indoor Farms

31
Greenhouses

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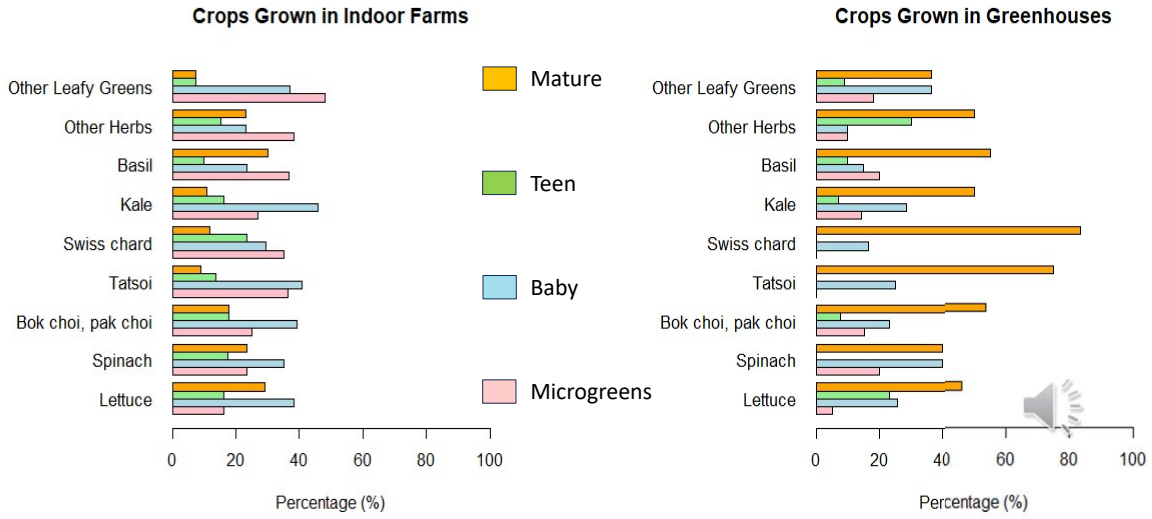


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More diversity in type and maturity of crops. Herbs are sold as microgreens. Other crops are mostly sold as baby.

Except spinach, which is sold as baby or mature, all other suggested crops are grown to maturity

Crops grown and maturity at harvest per crop grown

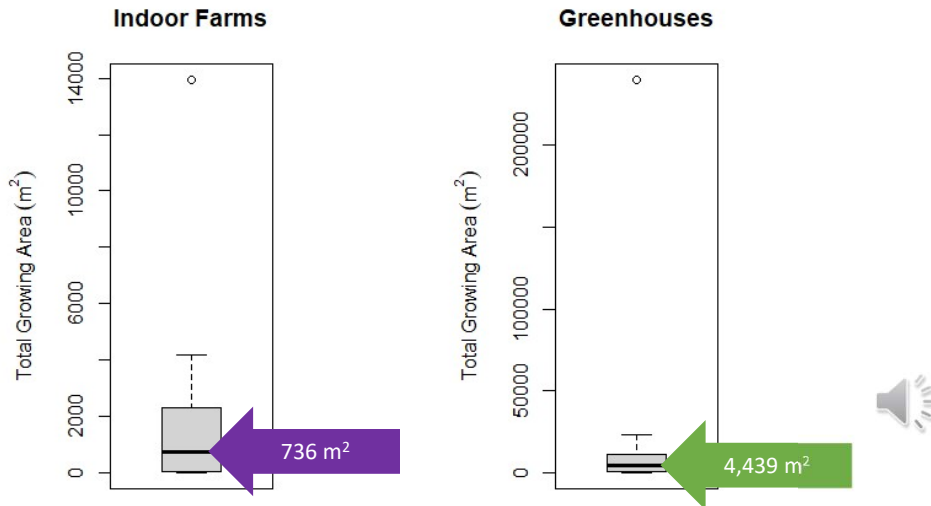


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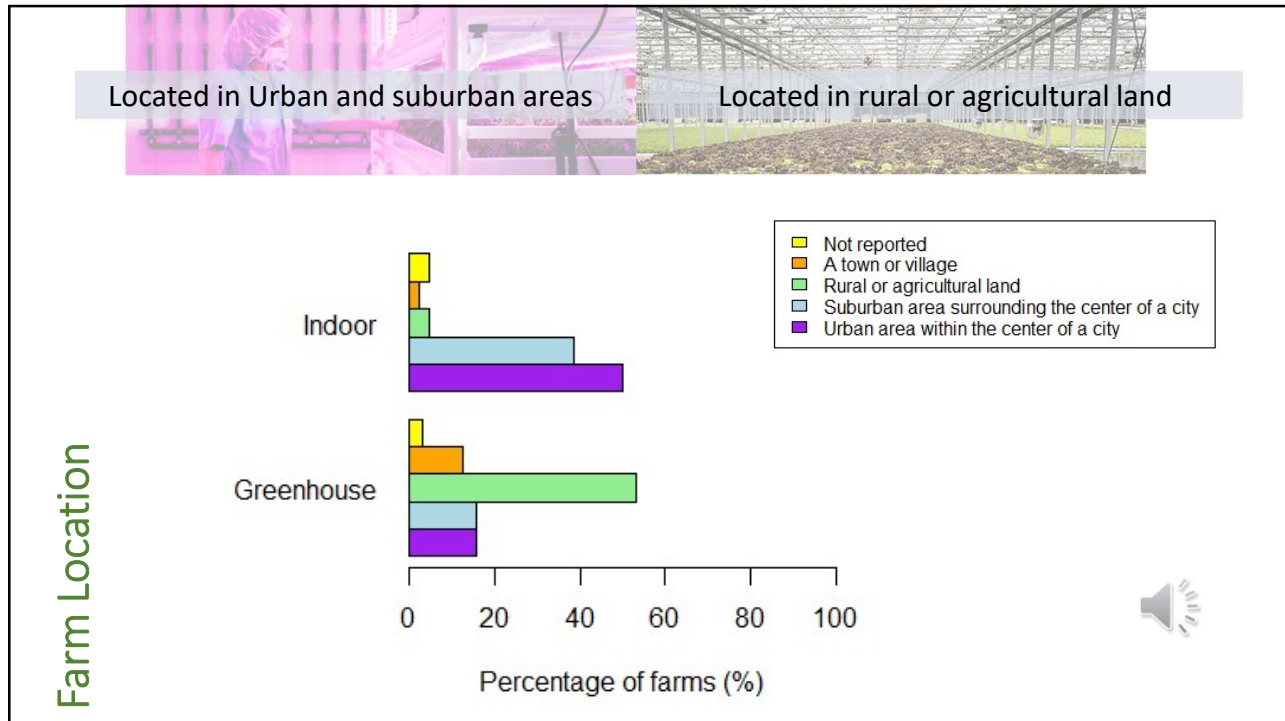
Smaller growing area

Larger growing area

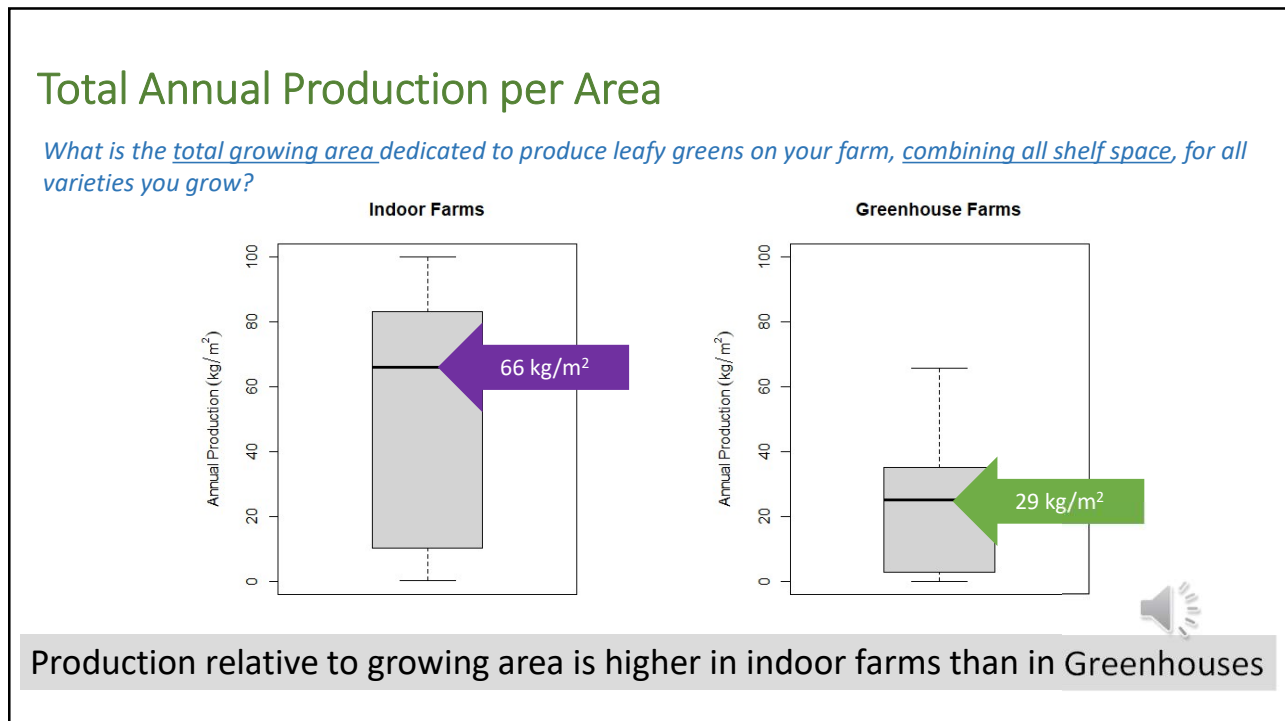
Farm Size: Growing Area



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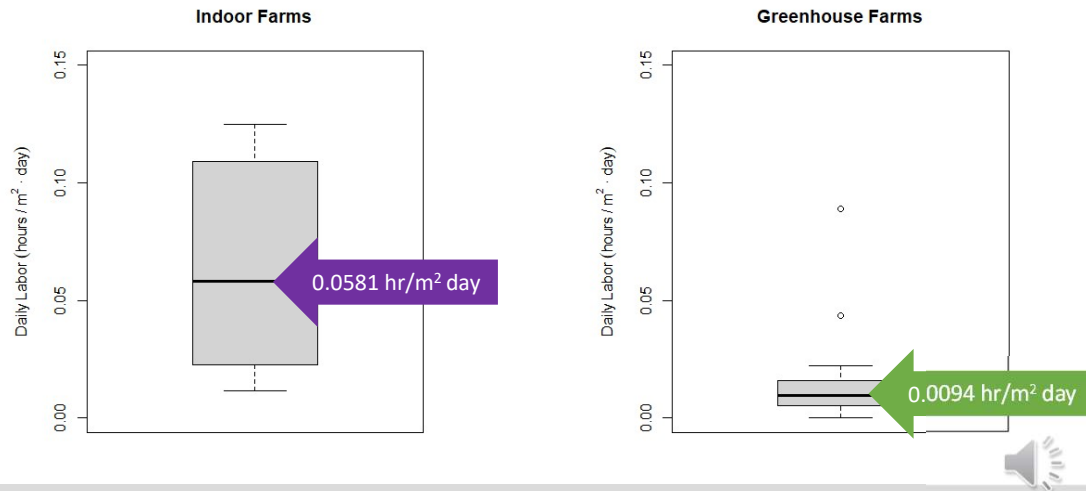


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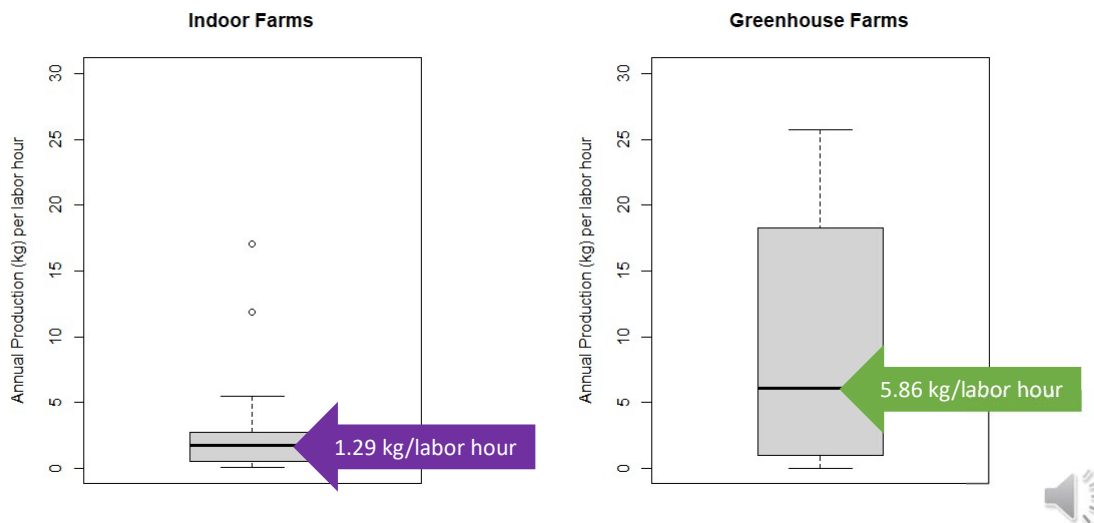
Daily Labor per Area (labor hour per m²-day)



More labor hours are required per m² day in Indoor Farms relative to Greenhouses

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Total Annual Production per Labor hour



Production in kg per labor hour is smaller in Indoor Farms than in Greenhouses

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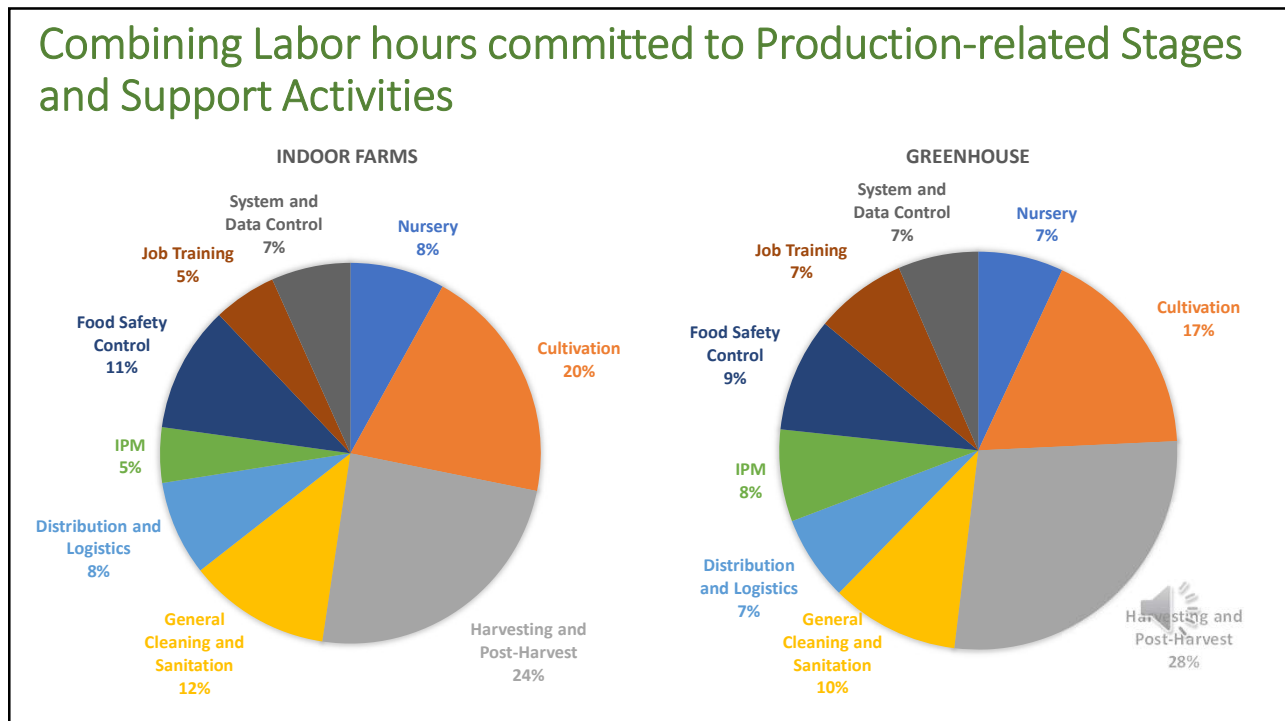
1) Labor hours (%) committed to:

2) Automation

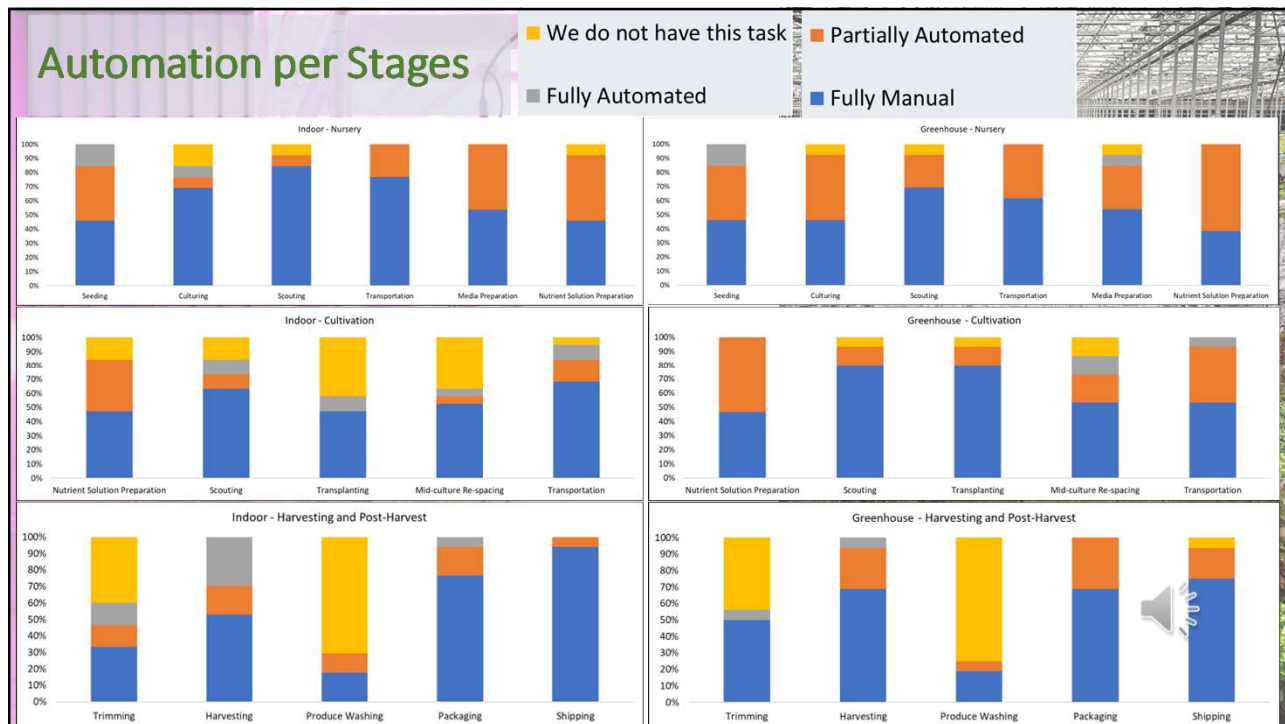
Production-related activities	
Nursery	Seeding Culturing Scouting Transportation Media Preparation Nutrient Solution Preparation
Cultivation	Nutrient Solution Preparation Scouting Transplanting Mid-culture Re-spacing Transportation
Harvesting and Post-Harvest	Trimming Harvesting Produce Washing Packaging Shipping
General Cleaning and Sanitation	General Cleaning System Sanitation Worker Sanitation
Distribution and Logistics	Warehouse Operations Delivery Logistic Coordination

Support activities
Integrated Pest Management (IPM)
Food Safety Control
Job Training
System and Data Control

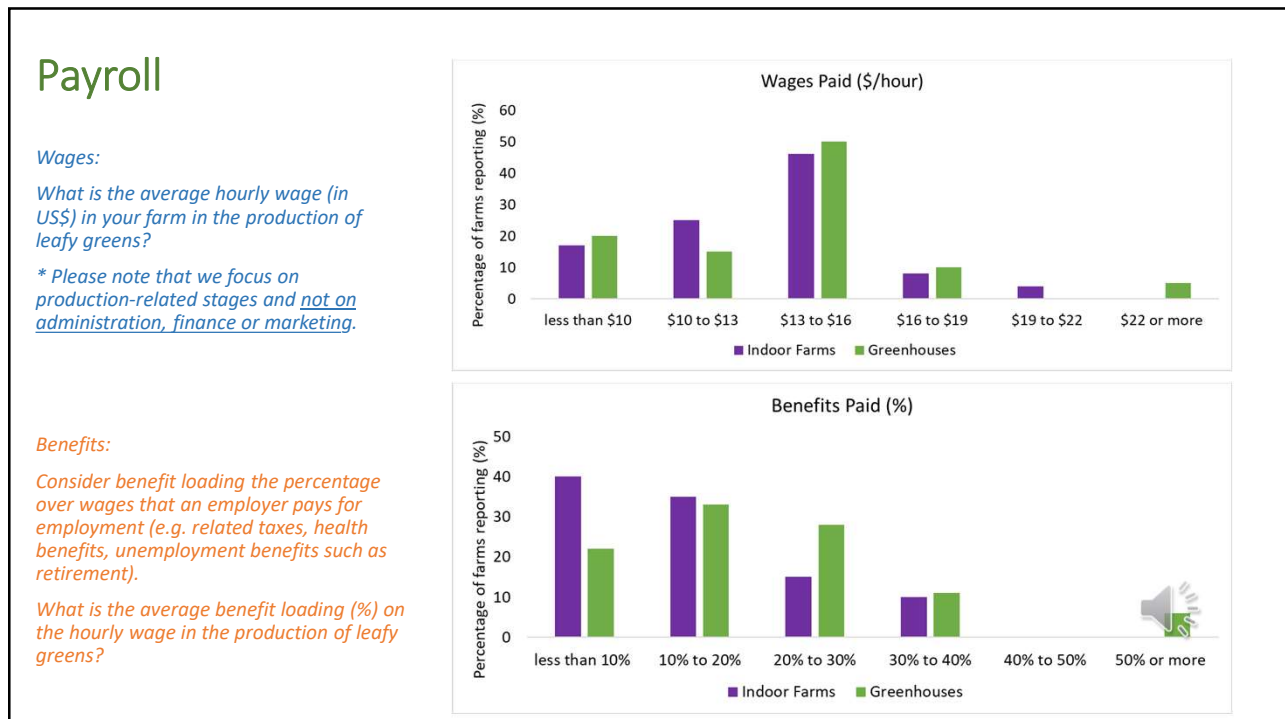
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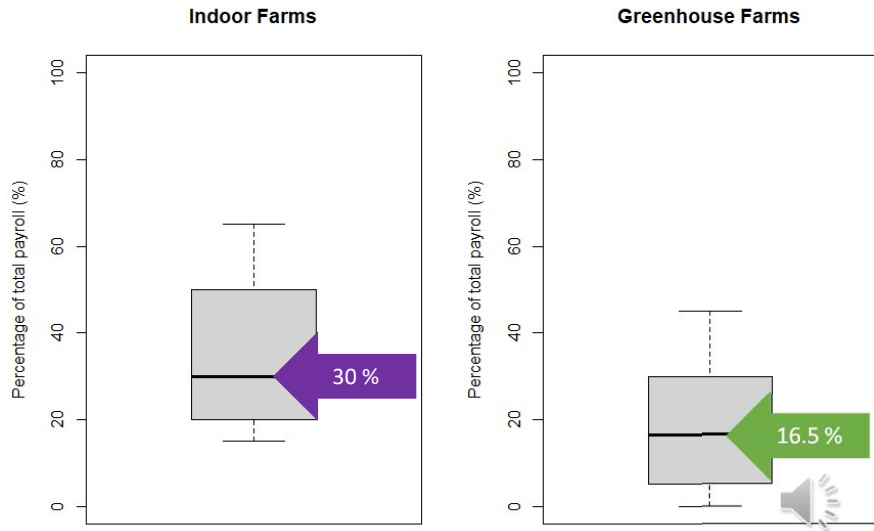
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Payroll

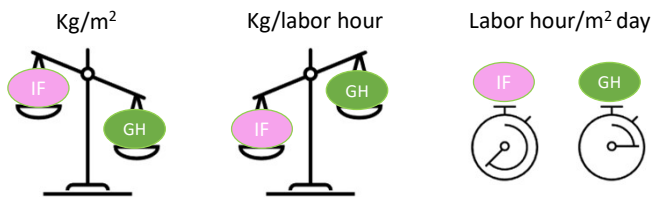
Percentage of total payroll committed to Administration, Finance and Marketing Personnel (%)



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Labor costs and Productivity Index

Survey data findings: Indoor Farms are more labor-intensive than Greenhouses



Findings from the Productivity Index Analysis: Greenhouses have much lower labor costs

- Indoor Farms and Greenhouses (mostly) pay similar wages, but Greenhouses (mostly) offered higher benefits.
- Indoor farms had higher percentage of total payroll committed to Administration, Finance and Marketing Personnel



<i>Index (median values)</i>	<i>Unit</i>	<i>Indoor Farms</i>	<i>Greenhouses</i>
Labor costs (Production-related)*	\$/m ² ·day	1.02	0.18
Labor costs (adding Adm, Fin, Mkt)*	\$/m ² ·day	1.33	0.21
Productivity of Labor	kg/wage \$	0.06	0.26
Costs of Labor per kg of Production	wage \$/kg	18.03	3.82

* Total growing area

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Overall conclusions

- Indoor Farms (shorter cycles and higher plant density) can achieve higher yields per area but are also likely to be more labor-intensive than Greenhouses.
- Productivity Index Analysis showed that higher labor requirements, could make labor costs per kg of produce 4.7 times larger in Indoor Farms.
- Important training skills needed in CEA farms:
 - Indoor Farms tend to use more manual labor in the nursery stage, and more automation in the harvest and post-harvest stage.
 - Greenhouses need more workers in the cultivation stage.
- Indoor Farms have to focus on quality attributes that attract a price premium while simultaneously implementing efficient operating standards.

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Thank you!



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