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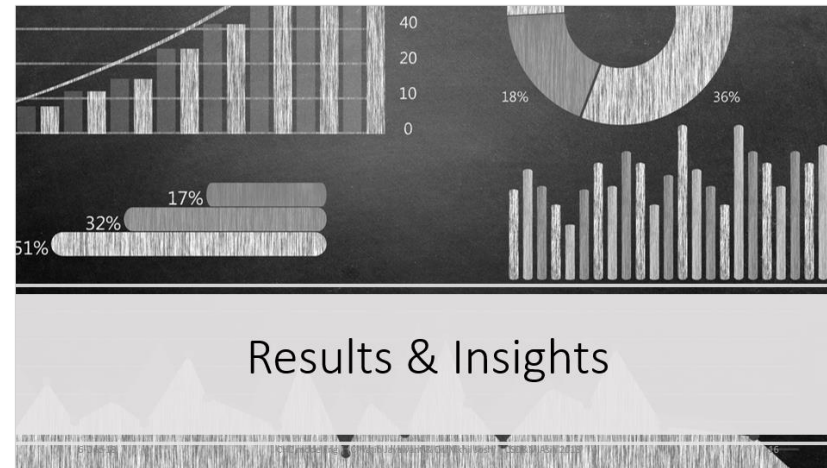


Modeling Operations of a Custom Hiring Center Using Agent Based Modeling and Discrete Event Simulation

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Outline





Background

What is Custom Hiring Center (CHC)?

- A company or an individual that owns a fleet of equipment and provides it (or specific services using those equipment) on rent to farmers
- Benefits of CHC & in-turn mechanization
 - productivity and income of small and marginal farmers increased 10–15%
 - effective use of expensive machines



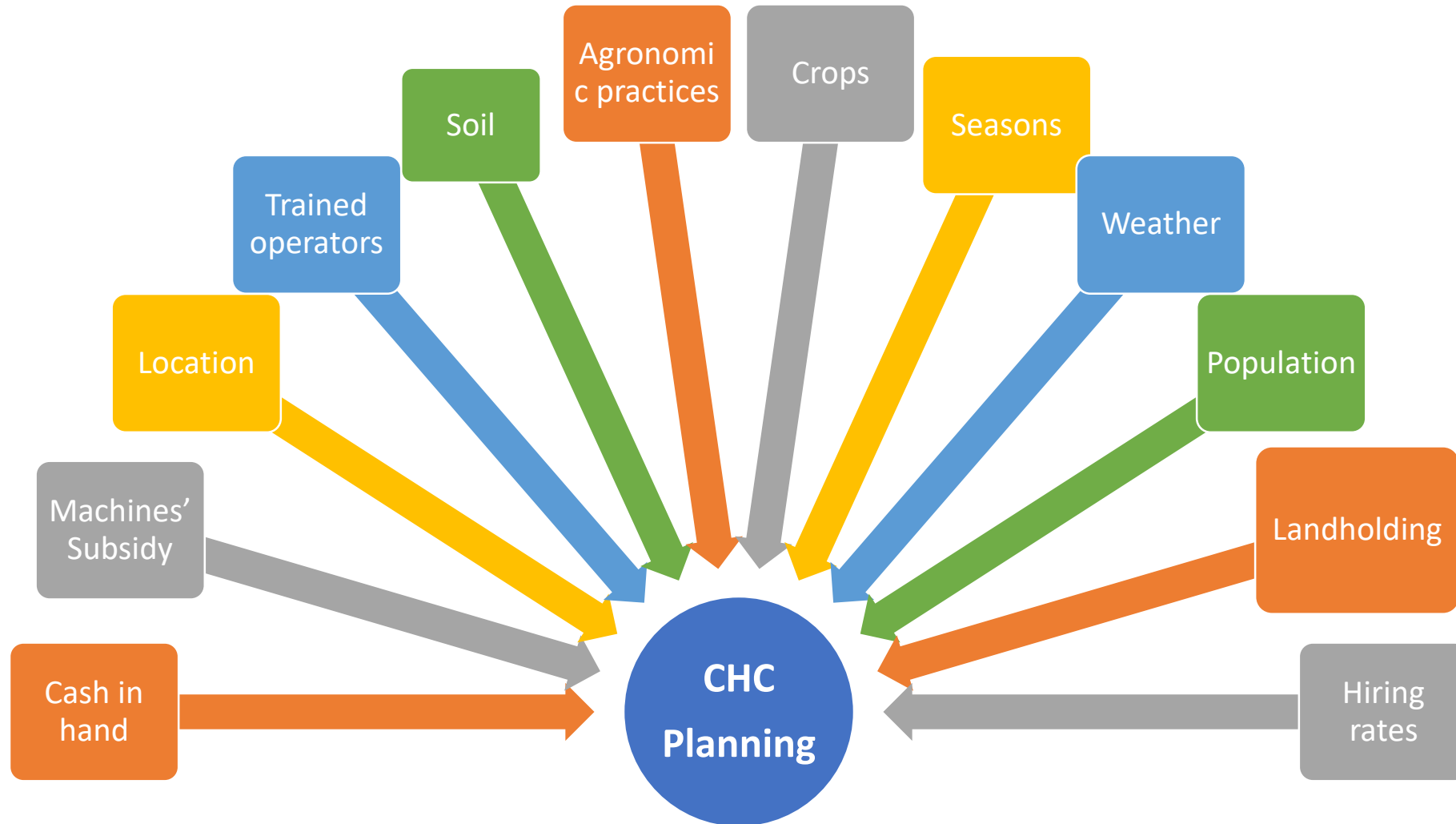
CHC Stakeholders

Stakeholder (type)	Needs	Benefits
Contractors/ CHC owners (Primary)	Faster return on Investment Optimal Fleet utilization Easy Access to customers	Increased market share / Better market reach Efficient operations management Higher profits
Farmers (Primary)	Increase in agricultural yield and income Equipment Availability Reduction in operations cost Access to advisory services	Easy and timely access to equipment Effective crop life cycle management Information about seed, soil and fertilizers
OEM (Secondary)	Increase market share Compliance with regulations	Increase in revenue Profitable, responsible corporate citizen
Regulatory Bodies / Government (Secondary)	Regulate industry operations Reach to poor	Ensure reliability and security Effective use of resources
Advisory service providers (Secondary)	Additional business/ revenue Research data	Accessibility to Farmers
Money lenders (Secondary)	Future prospects of business its lending to	A method to evaluate future of business

Problem



Factors affecting CHC



CHC: Deciding factors (focus of paper)

Type of machines

- **Inappropriate equipment choice**



Number of machines of each type

- **Insufficient or excess number of equipment of a particular type**



CHC economics

Profit = f

*machine utilization
population (customer base),
landholding,
time window of operation,
rental,
machine field capacity,
fuel consumption,
fuel cost,
machine price,
depreciation,
interest,
taxes, insurance, housing,
CHC admin cost,
farmer's patience in getting the machine,
number of machines*

Problem formulation

$$Profit = Revenue - Expenses$$

Revenue

- \sum Equipment working time \times Custom hiring rate

Expenses

- CHC admin cost + Self propelled equipment expenses + Trailed equipment expenses
- Self propelled equipment expenses = Repair & maintenance + (taxes, insurance, housing) + interest + (Fuel price * Fuel consumption * working time)
- Trailed equipment expenses = Repair & maintenance + (taxes, insurance, housing) + interest

Equipment working time



Simulation modeling

Modeling Approach: multimethod modeling

Agent Based Modeling (ABM)

Agents –

- Individual entities
e.g. farmer, machine, etc.
- Defined behavior & properties
e.g. landholding, fuel consumption, etc.

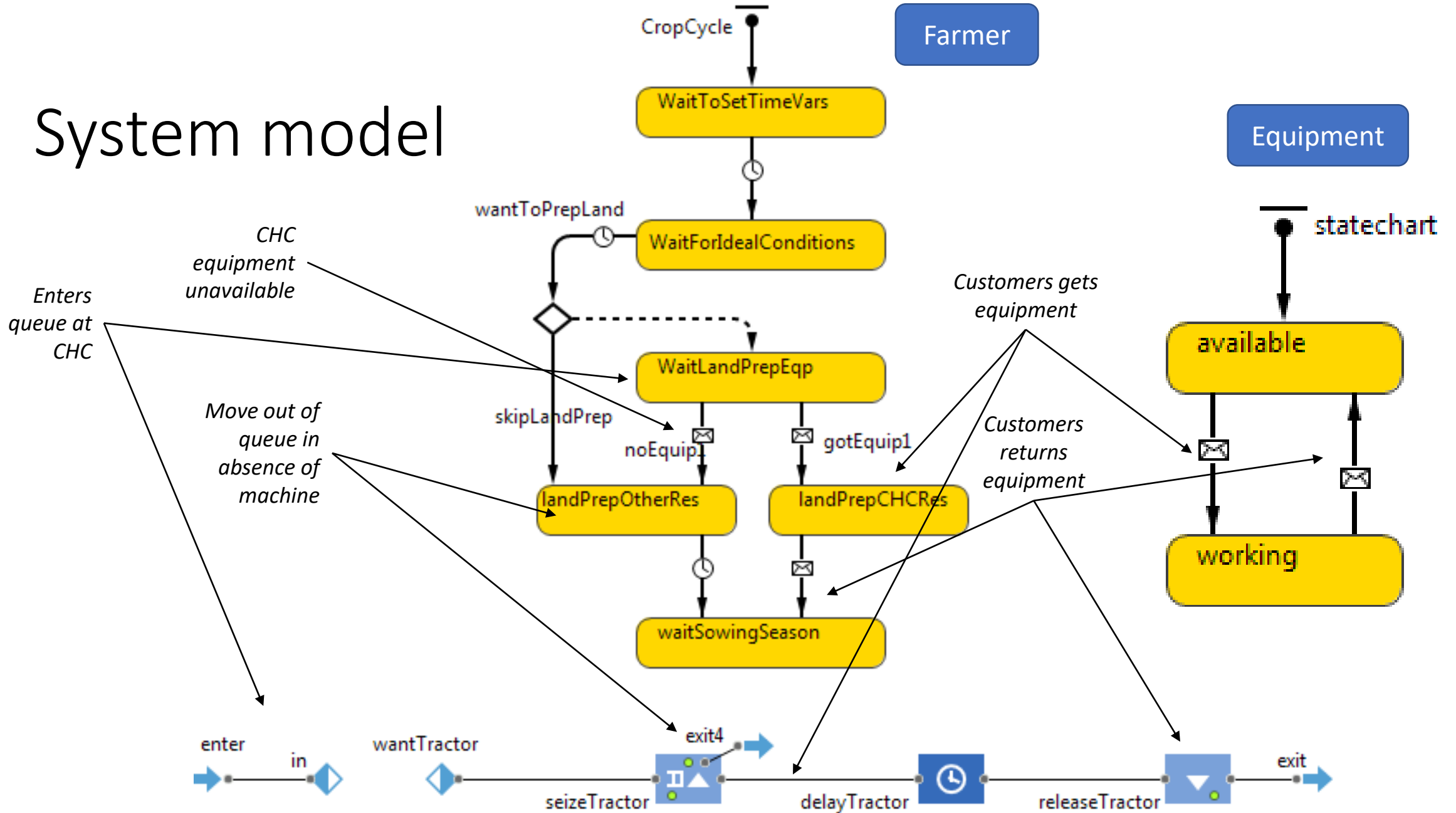
Discrete Event Simulation (DES)

- DES models the system as a series of ‘events’ that occur over time. e.g. a birth, a stay in an intensive care unit (ICU), a transfer or a discharge
- Each event occurs at a particular instant in time and marks a change of state in the system.
- DES assumes no change in the system between events.

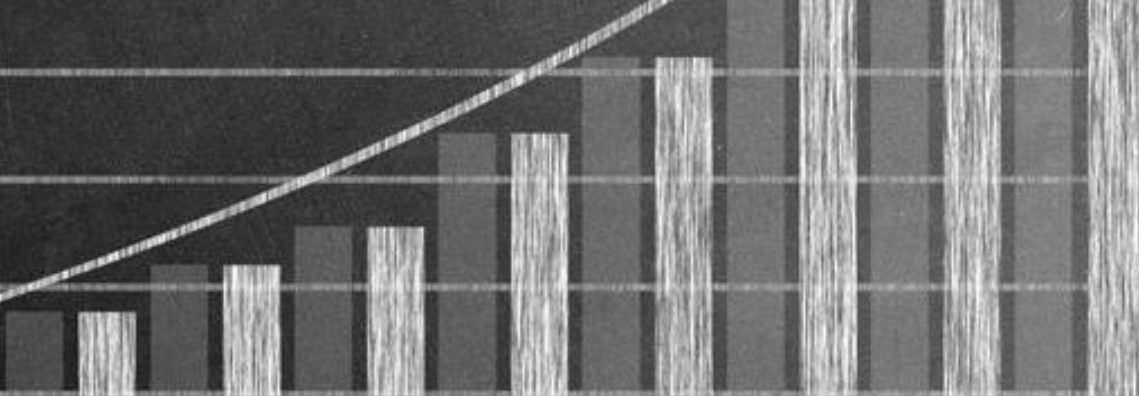
Ref:

<https://www.ncbi.nlm.nih.gov/books/NBK293948/>
https://en.wikipedia.org/wiki/Discrete_event_simulation

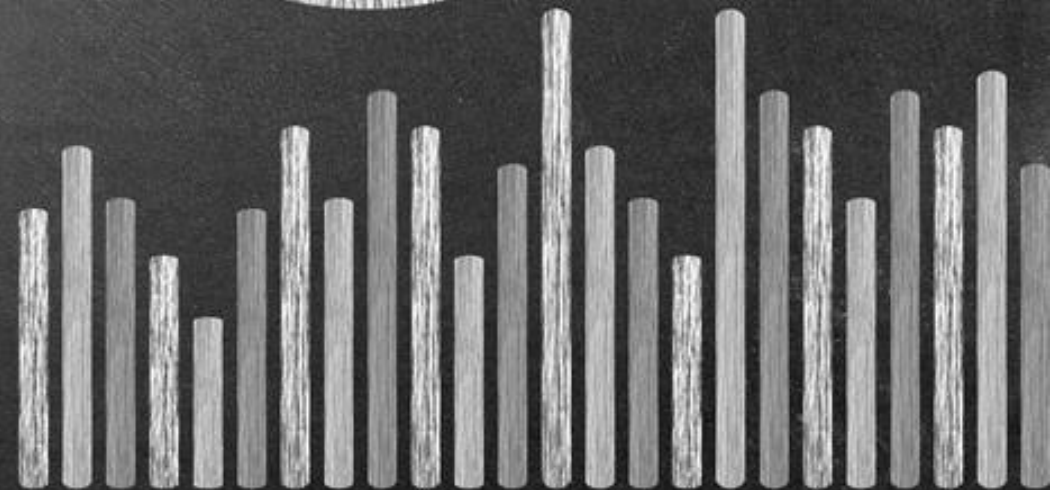
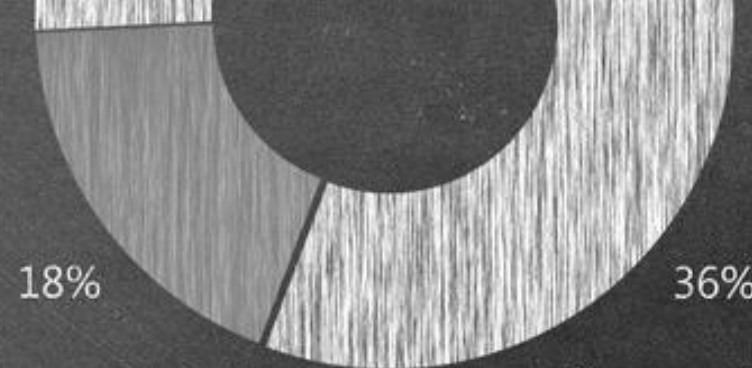
System model



Simulation (video)

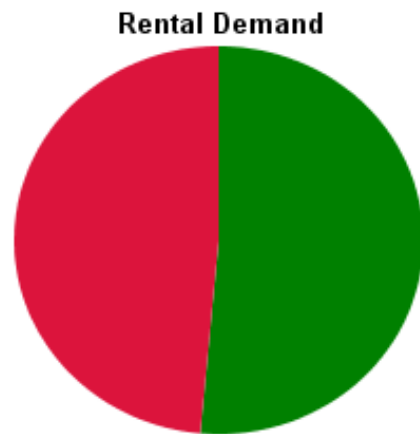


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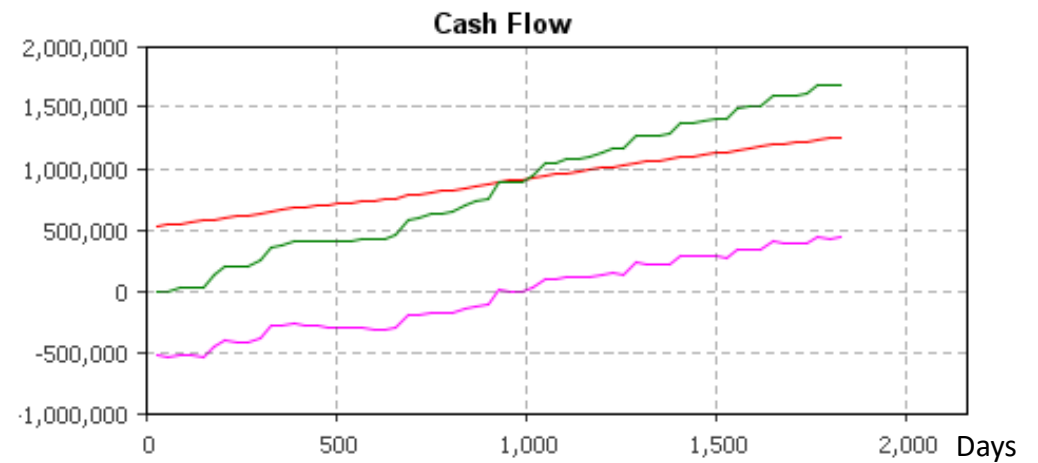


Results & Insights

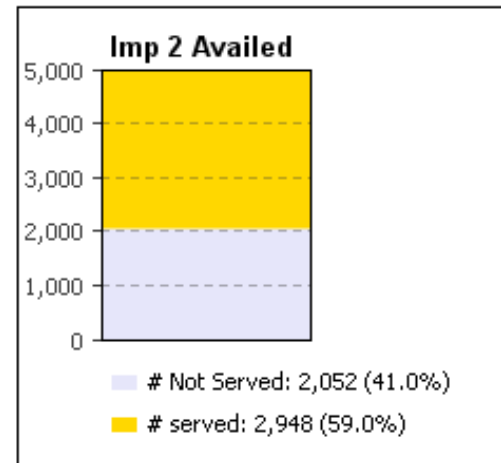
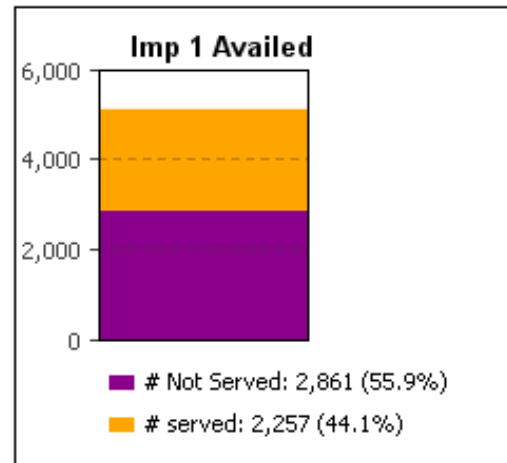
Results



■ # of requests Served: 5,205 (51.4%)
■ # of requests unmet: 4,913 (48.6%)



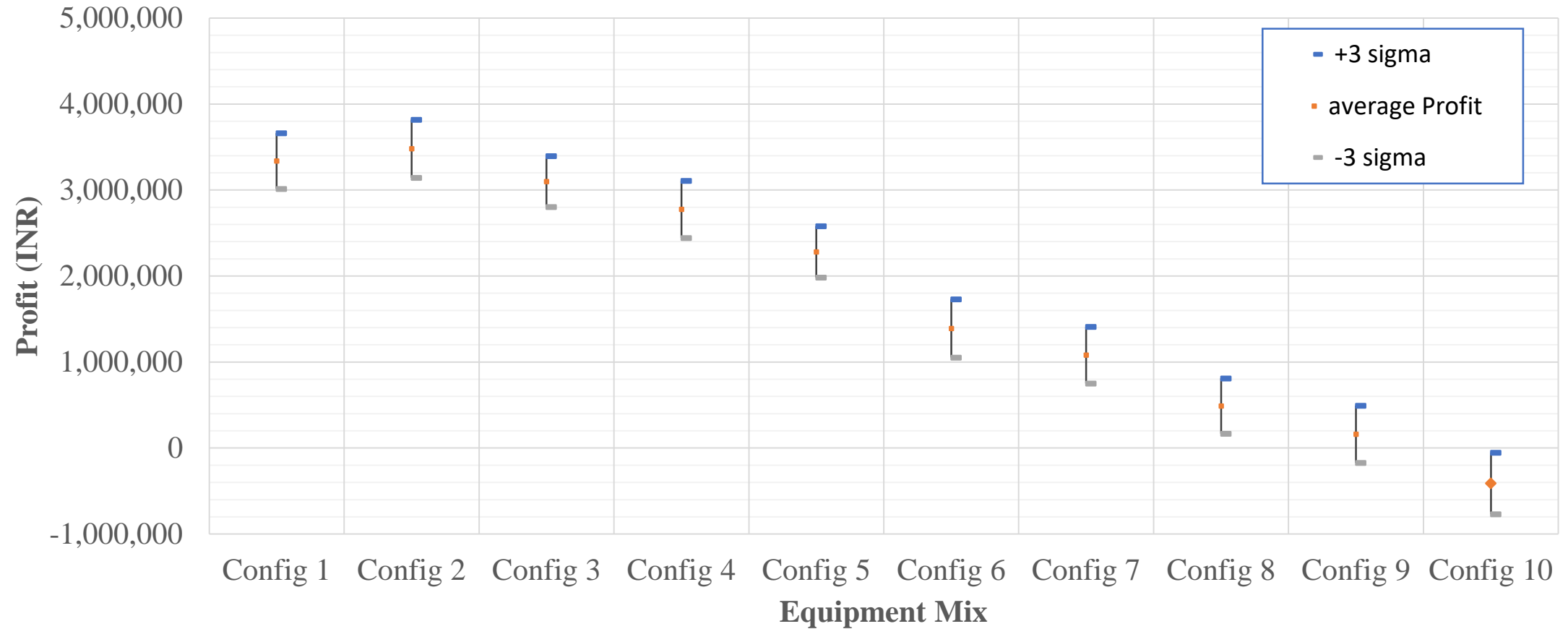
V cumulative_expenses
1,254,147.352
V cumulative_revenue
1,686,121.412
V cumulative_net_income
431,974.06



Run: 1 ● Finished | Time: 1831.00 | Simulation: 100% | Date: Jan 6, 2020 12:00:00 AM | ▶ | Memory: 68M of 989M 🗑️

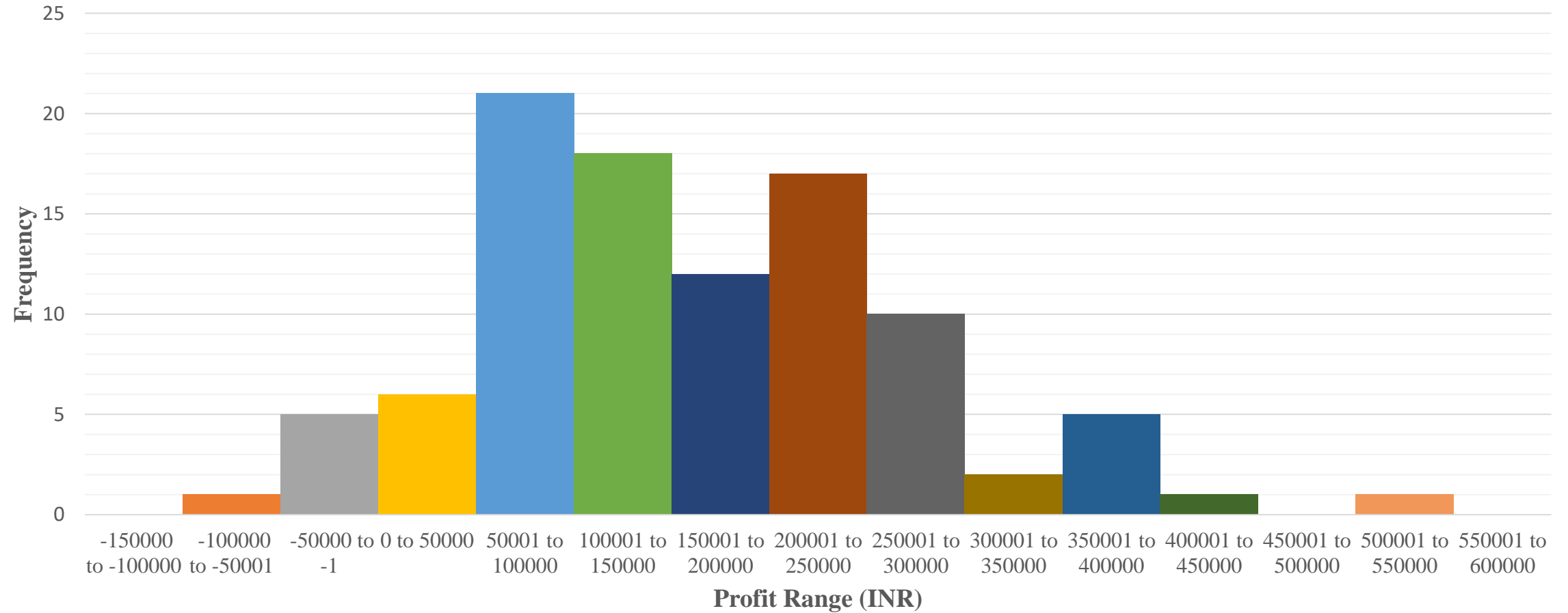
Result

Expected profit for different CHC configurations



Result

Histogram for expected profit of configuration 9



Results: Evaluating impact factors

Factors in control

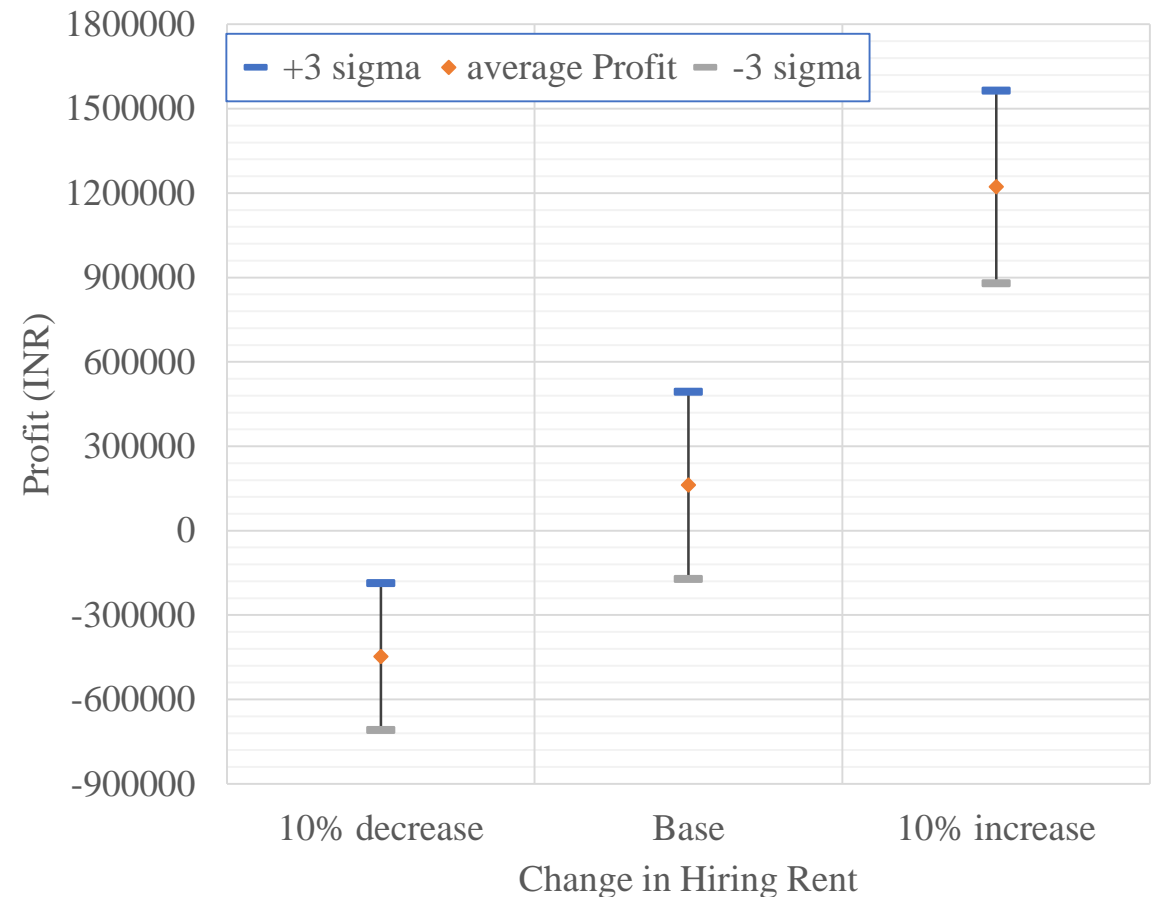
- Equipment to buy, hiring rent, schedule

Factors can be influenced

- number of farmers asking for equipment i.e. customer base, farmers' patience

Out of control

- cropping pattern, season or time window of operation, fuel price



Impact of change in rent on expected profit of configuration 9

Summary

- Presented an approach to simulate the CHC operations using Agent-Based Modeling and Discrete Event Simulation approaches
- Determined profitability based on varying factors
- Modelled farmers' behavior
- Applications
 - Original Equipment manufacturer (OEM): suggest number of machines to buy
 - Financial institution / Bank: decisions for disbursing loans
 - CHC: effect of prioritizing requests, choices between single & multi-purpose machine



Directions for future work

- Effect of weather changes
- Effect of interaction and word of mouth
- Effect of machinery breakdowns
- Tool for
 - Demand aggregation
 - Order management
 - Scheduling and allocation (daily/weekly)
 - Payment services
 - Reporting
 - Resource utilization, machine health tracking and management



Thanks
