



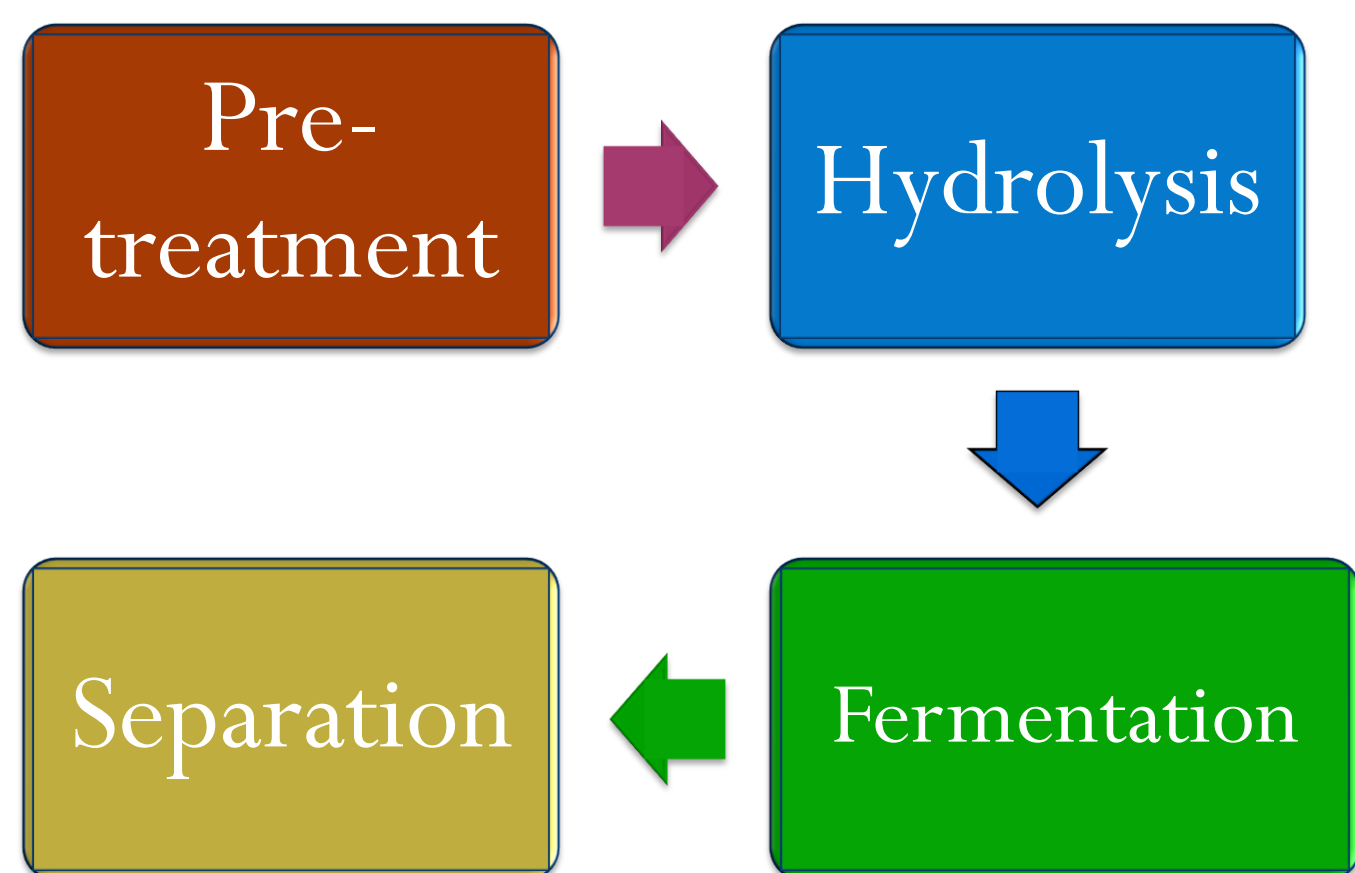
Quantification of uncertainty and parametric sensitivity in lignocellulosic ethanol production



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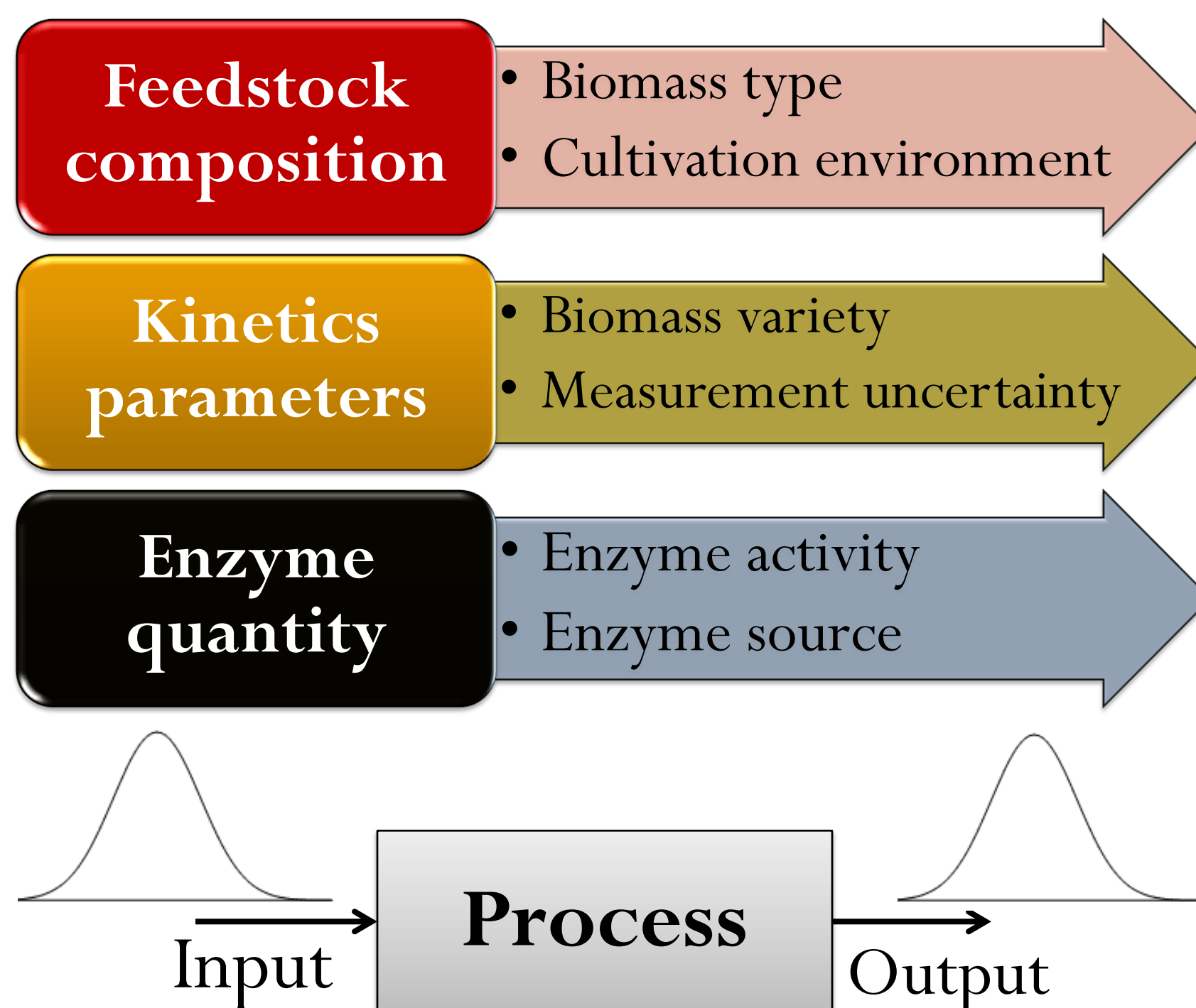
Lignocellulosic Ethanol Production



Advantages over other fuel sources:

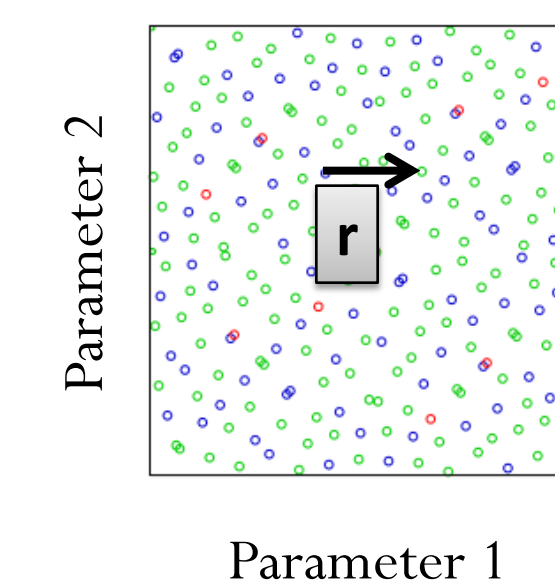
- Uses existing agricultural practises
- Low green house gas emission
- No competency over food crops
- High-octane performance at relatively low cost

Uncertainties And Their Impact



Sensitivity Analysis

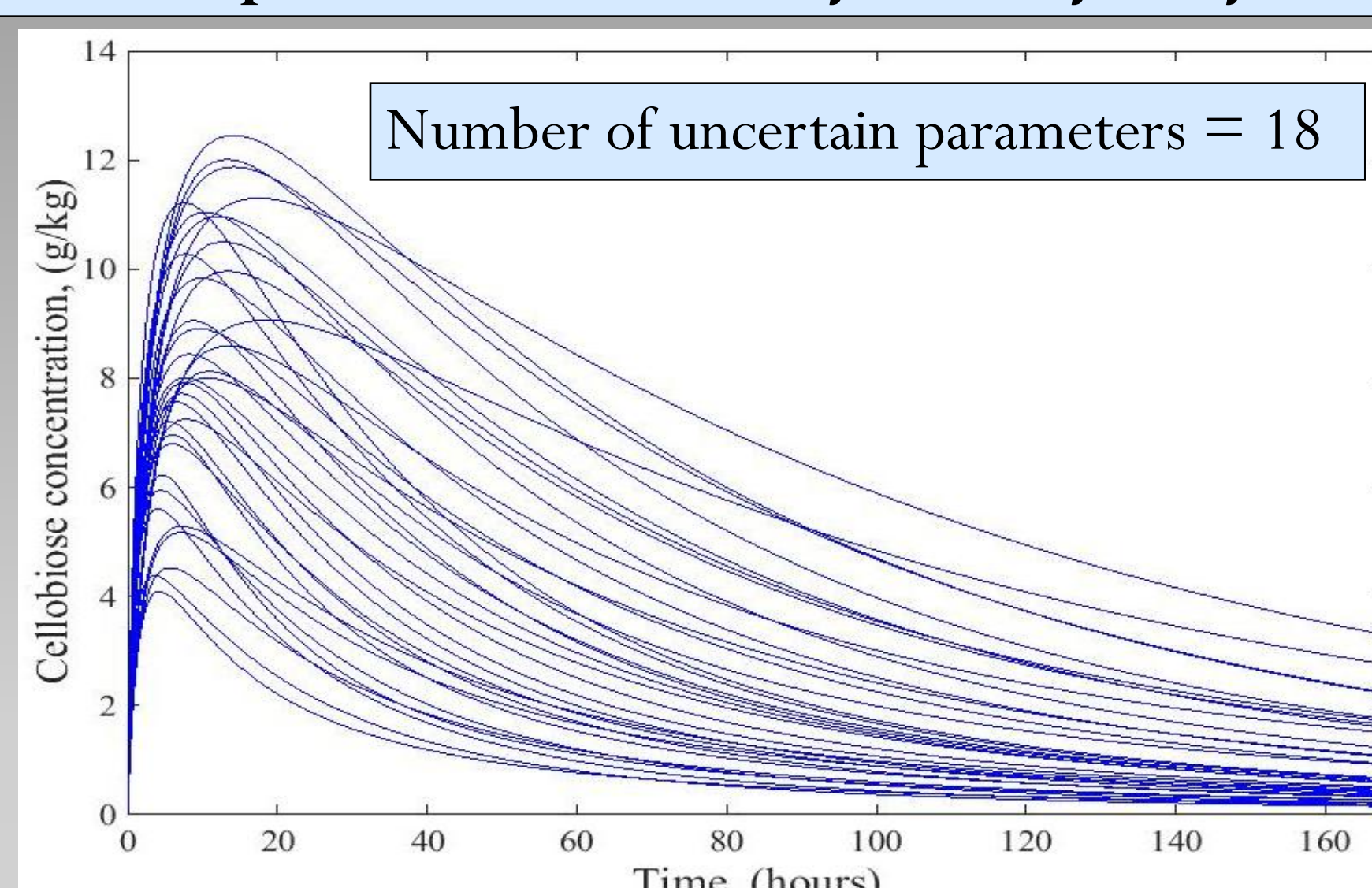
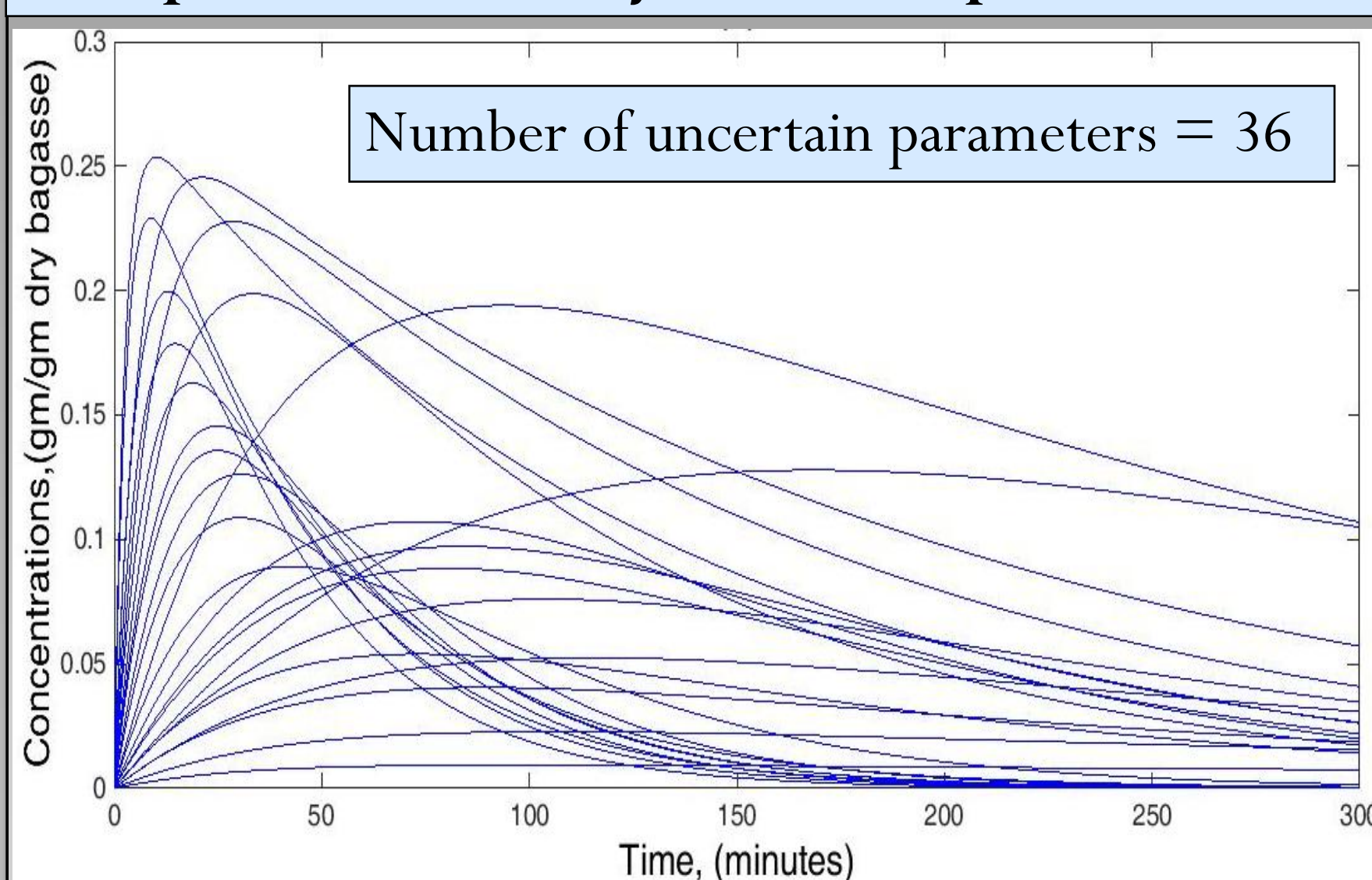
A global analysis method by combining the local technique with Monte Carlo sampling



- Initial set of random samples
- Perturbation around each sample by $|r|$
- Tracking output change for all such possibilities
- Numbers of sample=500
- $r = [-0.2 \ -0.1 \ 0.1 \ 0.2]$

Stochastic Simulation Results

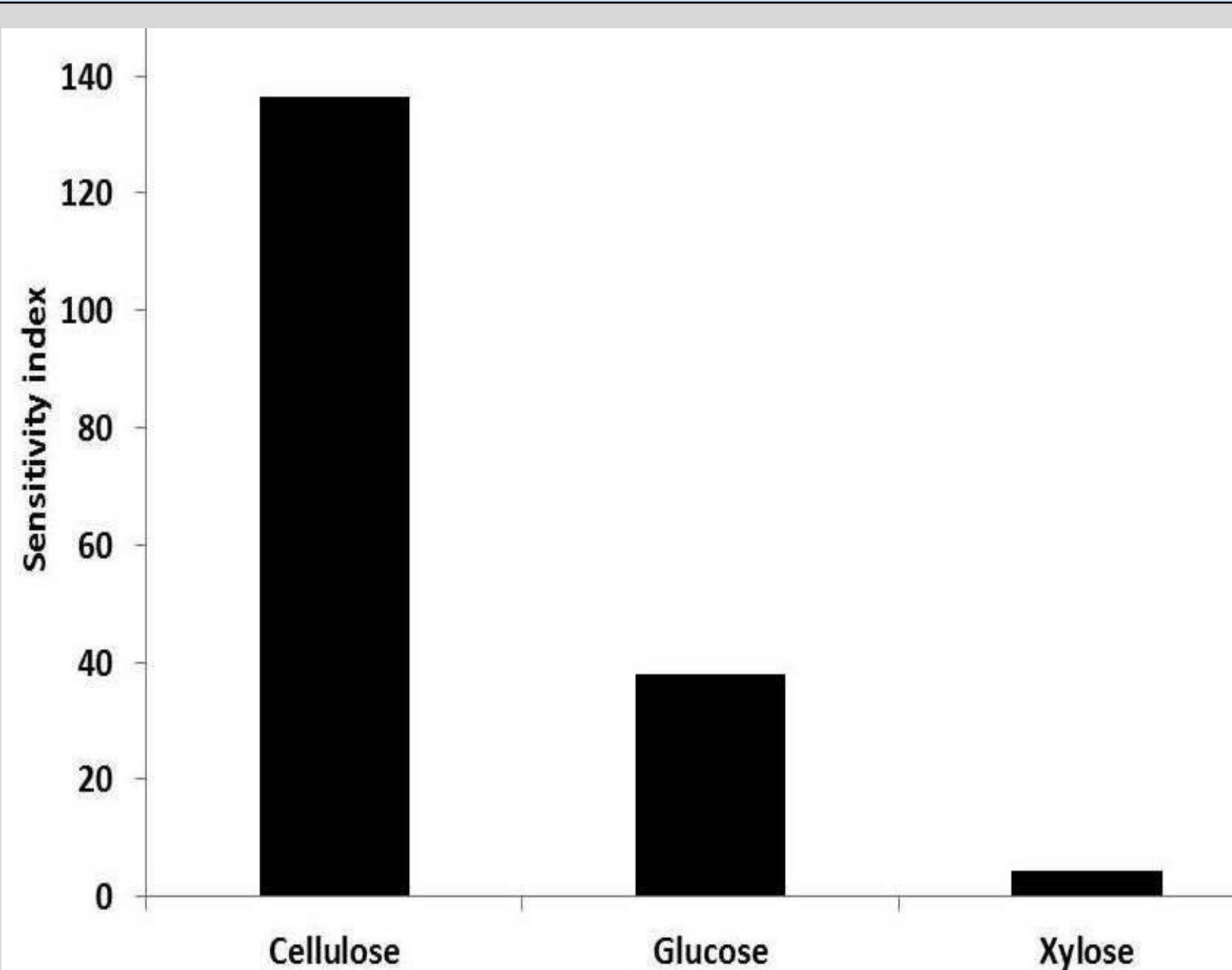
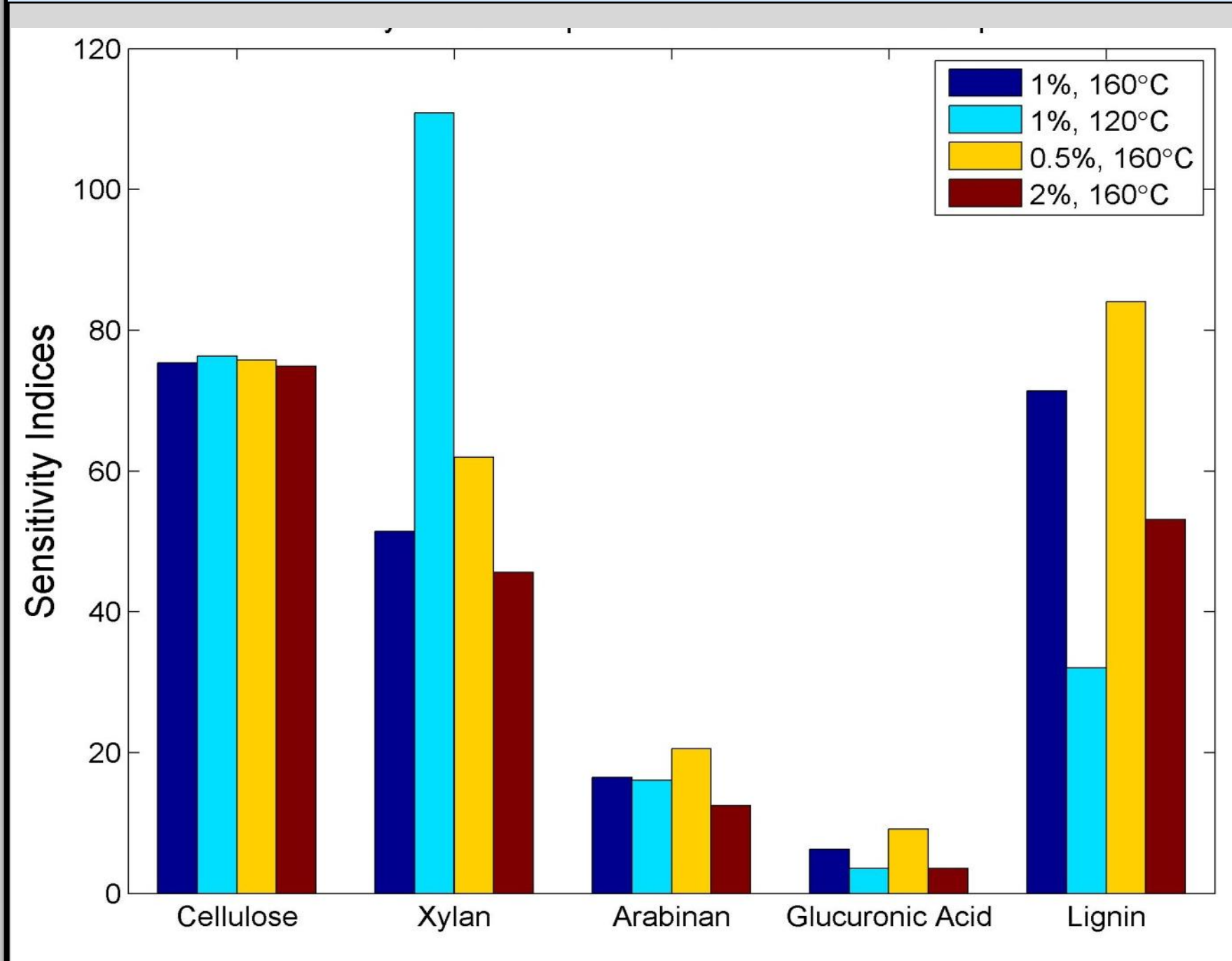
Impact of variability in kinetic parameters used for Acid pre-treatment & Enzymatic hydrolysis



No.	Uncertain factor	Glucose (g/kg)	Xylose (g/kg)
1.	Enzyme loading	55.05 ± 6.165	-
2.	Model parameters	59.43 ± 3.999	0-260
3.	Temperature	60.92 ± 0.852	50-200
4.	Feed-stock	59.73 ± 4.001	152.7 ± 36.9

Sensitivity Analysis Results

Sensitivity of desired product w.r.t. feedstock composition for acid pre-treatment & Enzymatic hydrolysis



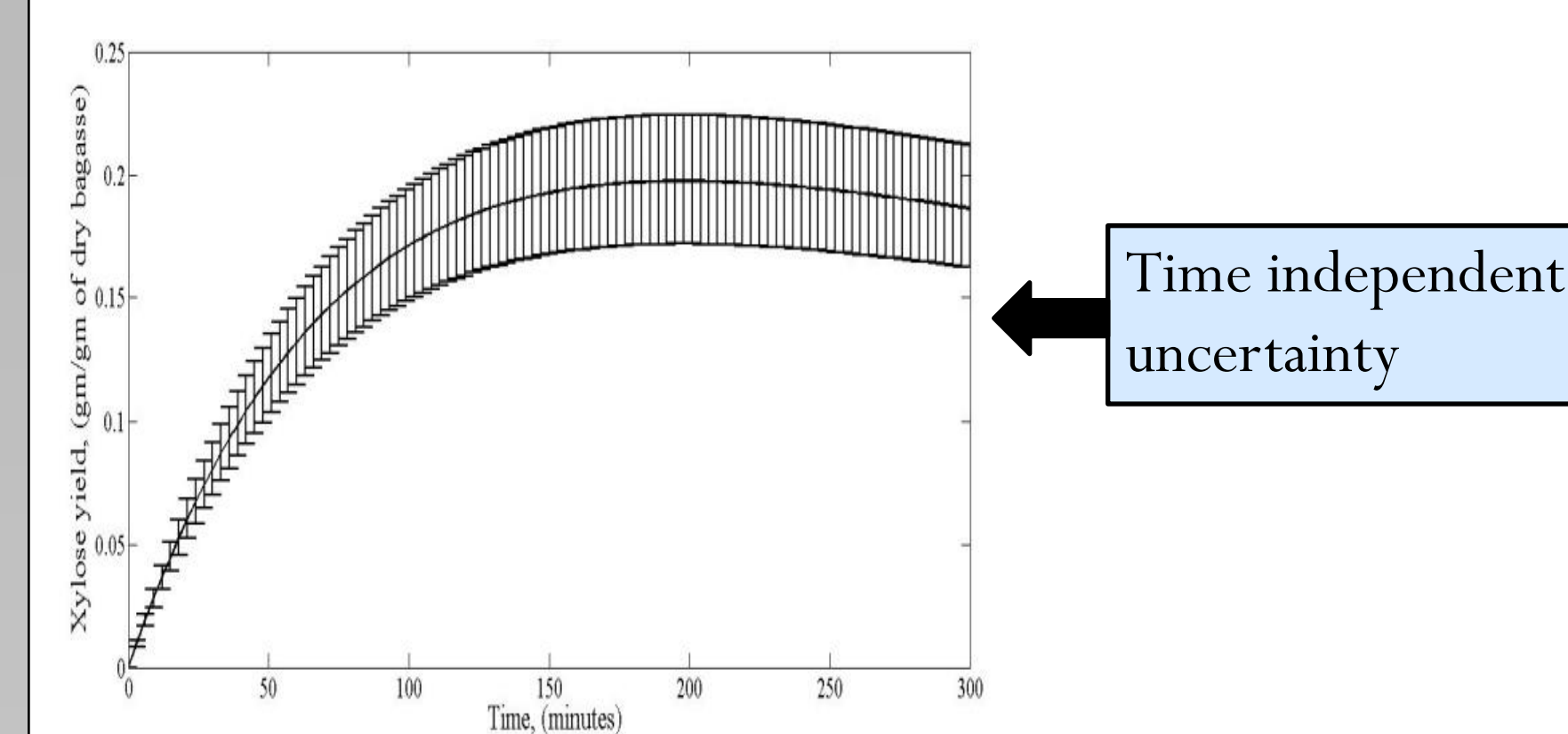
Sensitivity ranking for desired product w. r. t. :

- Kinetic Parameters : E_{1c} , E_{1f} , E_{1l} , E_{1x} , E_{2c}
- Operational parameter : Temp.
- Overall : Temp., E_{1c} , E_{1f} , E_{1l} , E_{1x} , E_{2c}

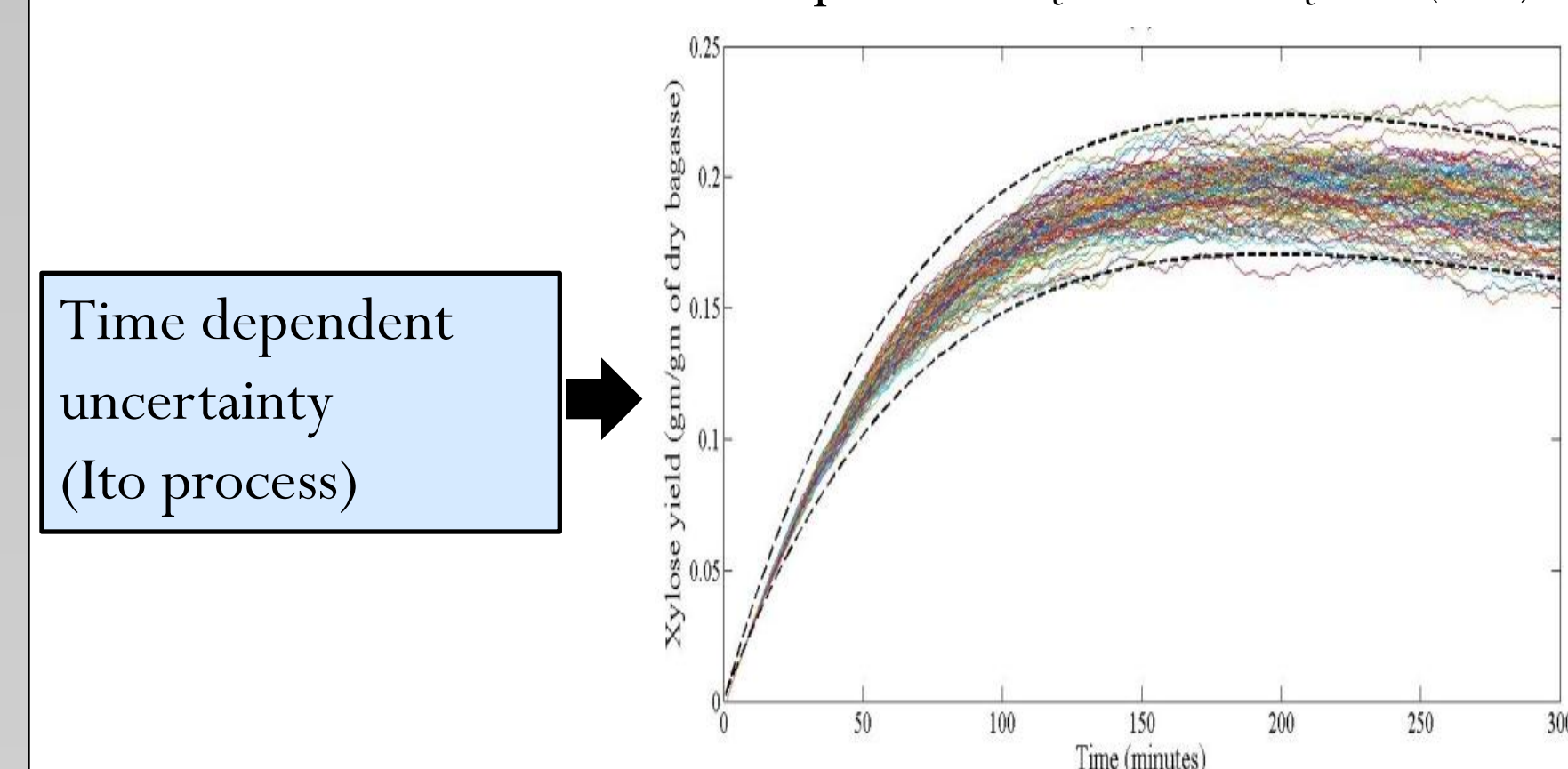
Sensitivity ranking for desired product w. r. t. :

- Kinetic Parameters : E_a , k_{1ad} , α , k_{1r0} , k_{2ad}
- Enzyme: β - glucosidase
- Overall : E_a , Temp, Cellulose, β - glucosidase, K_{1ad}

Stochastic modelling



Ito process in continuous time domain
 $dx = a(x, t)dt + b(x, t)dz$
 here, $dz = \text{Increment in wiener process}$, $\epsilon_t \sqrt{\Delta t}$ and $\epsilon_t \sim N(0, 1)$



Future Work

- Robust design and optimization of acid pre-treatment with considering the variability in feedstock composition and Kinetic parameters.
- Stochastic modelling and optimization of enzymatic hydrolysis.
- Integrated design of acid pre-treatment and enzymatic hydrolysis under the influence of variability.

References

- Verma, S. K.; Fenila, F.; Shastri, Y. Impact of uncertainties on lignocellulosic ethanol production. In ASABE Annual Meeting, paper number 152183859, New Orleans, LA, 2015.
- Wang, J.; Ye, J.; Yin, H.; Feng, E.; Wang, L. Sensitivity analysis and identification of kinetic parameters in batch fermentation of glycerol. Journal of Computational and Applied Mathematics. 2012, 236, 2268–2276.