# IFPRI Project Abstract

## High-Fidelity Numerical Modeling of Spray Droplet Formation

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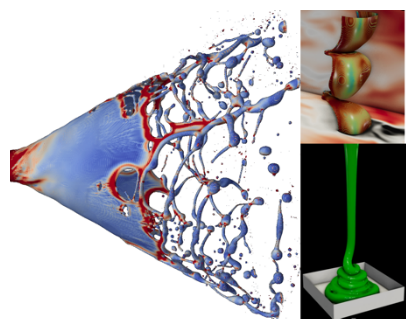
### *Project Objective:*

The objective of this project is to assess and enhance the ability of a novel multi-scale, high-fidelity computational modeling framework for spray formation to predict drop size and velocity distributions in high-viscosity and non-Newtonian liquid atomization systems, such as found in spray drying applications.

### *Approach:*

This project employs a novel multi-scale computational modeling framework for predicting sprays within the open-source NGA2 code based on:

- High-fidelity simulations of injector, spray formation, and spray dispersion in separate but coupled computational domains,
- Sub-grid scale tracking of thin interfacial structures such as ligaments and sheets,
- Explicit physics-based modeling of the break-up of these thin structures into Lagrangian droplets.



### *Recent Results:*

Since Fall 2022, three main tasks were accomplished:

1- A suitable approach for modeling complex fluids was identified, implemented in NGA2, and tested. This model combines the effect of shear-rate-dependent viscosity via a Carreau model with constant-viscosity elasticity via a FENE-CR model for a Boger fluid.
2- After discussions with other IFPRI PIs and IFPRI liaisons, it was decided to focus on pressure swirl atomization: to that end, a canonical configuration was introduced in which the effect of increasing viscosity on spray formation can be studied first, as well as the effect of complex fluid rheology.
3- To better understand the microscale physics of non-Newtonian atomization, multiscale simulations of the break-up of isolated liquid ligaments in turbulence were performed, providing deeper insights into the atomization of complex fluids.

### *Next Steps:*

This first phase of this project was exploratory in nature. As confidence in the applicability of our numerical methods grows, we will turn our attention to quantitative characterizations of the pressure swirl and isolated ligament simulations. Moreover, we will simulate conditions for which quantitative comparisons against experiments is possible.