

## IFPRI Project Brief

### Design of Vibrators and Air Assistance Systems for Reliable Flow from Bins and Hoppers

Reliable gravity flow within confined systems, such as bins and hoppers, relies on ensuring that the stress exerted on the powder near obstructions exceeds its cohesive strength. Similarly, the flow along a transfer chute is guaranteed if the gravity forces surpass the wall friction.

To address these challenges, design equations rooted in fundamental engineering principles, pioneered by Andrew Jenike, offer a means to calculate the required stresses to overcome flow obstructions in storage vessels with converging walls and enable smooth sliding on sloping surfaces. However, the design and optimal placement of flow-promoting devices like vibrators, air pads, and air sweeps for reliable operation lack clear guidelines.

This project aims to provide engineers with a comprehensive framework for design of flow promoting systems based on fundamental principles. It will guide the selection and design (location, number, intensity, etc.) of these technologies to overcome flow interruptions in hoppers, bins, silos, and transfer chutes, thereby ensuring consistent and reliable material flow.

We believe the project should consider the following elements:

1. Gain a comprehensive understanding of the contrasting impacts of vibration and air injection on enhancing solids stress within confined systems, particularly those with sloping walls. Recognize how these factors influence the material's cohesive strength, potentially impeding flow, as well as how they can increase bulk density and external stress to promote flow.
2. Determine the optimal utilization of vibration and air assistance technologies to facilitate material flow in unconfined systems, such as inclined transfer chutes. Consider scenarios where gravity flow is hindered due to practical constraints, such as insufficient steepness of the chute angle.
3. Develop models and/or equations grounded in fundamental engineering principles that enable precise specification of vibration and air-slide-assisted flow aids. These models should provide a reliable framework for designing and implementing these technologies in various bulk handling systems.
4. Establish best practices for accurately measuring critical powder flow properties that are essential inputs for the developed models and equations. Ensure that these measurements align with industry standards and guidelines, allowing for consistent and reliable data for effective design and implementation of flow aids.

The scope of this project includes:

1. Overcoming arching and ratholing within bins, transfer and hoppers systems to deliver reliable process flow.
2. At a minimum, address rigid process surfaces; however, we would welcome insight into flexible walled operations.

3. At a minimum, consider rigid brittle cohesive particles; however, we would welcome insight into ductile particles handling.
4. Design of new systems and retrofit of existing systems.