

Dear IFPRI Members,

Thank you for your comments about the CapCap proposal. Your question about the particle size and the role of air is very relevant. The point of view adopted in this study is that the aeration obtained during packaging processes result from both the cohesive nature of the powder and the coupling with air. The proposed strategy is to try to disentangle the two, by first studying how interparticle adhesion gives rise to very loose samples, even when the particles are coarse and the influence of air is negligible, before studying finer particles for which air is expected to play a role. We believe that the first step towards a better understanding of the behavior of powders is the control of the adhesion.

Please find the response to your detailed comments. The text has been modified accordingly.

**Overall, the members are enthusiastic about your proposal, however they note that you really aren't proposing to study Geldart Group C particles, rather you are studying Group D. Your particles are too large for aeration and deaeration to be relevant.**

**While your plan to grapple explicitly with particle cohesion is welcome, the coupling of aeration and cohesion is a key element to the brief. You weren't specific about the particle size you'll investigate, but the implication that they are O(millimeters). It would be useful to clarify this point.**

We now specify in the text that our method to coat particles and to control the adhesion works down to 100 micro particles. For this particle size, air flow starts to play a role during compaction or decompaction under earth gravity. For smaller particles, other adhesive forces become of the same order of magnitude as the one introduced by the coating, meaning that we no longer control the adhesive force. Our hope is that playing with both the particle size (from 100 $\mu\text{m}$  to 1mm) and the coating, we will be able to disentangle between the role of adhesion and the role of air in the control of the final compacity of the sample.

Moreover, since the writing of the first version of the proposal, we have been in contact with chemists from university of Lyon, who have developed new technics to synthetize polymer particles with tailored mechanical and surface properties. These particles have been recently used to investigate the role of particle interaction in suspensions but have never been tested in dry conditions. These particles can be synthetize in the range (10 to 500 micrometers), which will be an alternative to our PDMS coated particles.

**Also, your proposal was vague about the theoretical framework you will apply to analyze the data. It would be useful to discuss how you will apply what you learn in these experiments to address the questions posed in the project brief. (I should note that there is interest in Group D powders as well, and the general question of how cohesivity affects fundamental phenomena like yielding, compaction, and the Janssen effect is always of interest to IFPRI).**

The proposed research program is mainly experimental. The data and experimental analysis should help rationalizing theoretically the flow of powders. First, by controlling adhesion and size independently, we should be able to identify the relevant dimensionless parameters controlling the aeration during the packaging process, a key point to generalize to different kind of powders. The ultimate goal would be to propose constitutive equations to describe the flow of powders as a continuum, to inject them in a two phase-flow description and to be able to simulate flow in any configurations taking into account both cohesion and coupling with air... This represents the long-term project we have in mind, starting with the proposed program.

**Some more specific questions include:**

- **how thick are your PDMS films? Are they significant relative to particle diameter?**

The PDMS film is about few tens of nanometers, much smaller than the particle size.

- **do these films contribute to lubrication or create viscoelastic interactions between particles?**

This is a very good question. For very thick coating, viscoelastic interactions are certainly present, but not in the range of coating we have tested. However, we do not know yet about the lubrication, and more characterization about the particle interaction should be conducted.

- **can you confirm that you create a viscometric flow (i.e. shear stress spans the gap) in your annular shear cell? The gap is approximately 30x the particle diameter - how do you assure that a shear band doesn't form?**

To prevent shear banding we propose to study the rheology in very thin gap, less than 10 particle diameters. We have tested in DEM numerical simulation that using small system stabilize shear banding and provide the « bulk » rheological curves.

This can be easily tested experimentally by performing experiments varying the gap, and checking that the measured flow curve are independent of the gap, in this thin regime.