Hello everyone.

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The dry systems portfolio is healthy. Indresan Govender's project is up for renewal; although Karen Daniel's is ending next year, it is not too early to think how she could remain in touch with IFPRI; Prabhu Nott and Arno Kwade have done excellent work and will be up for renewal in 2023; Kit Windows-Yule and Jonathan Seville have come up with useful and provocative information on DEM; and we hope that Csaba Sinka will be off to a good start this coming year.

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We learned a lot this year. This slide shows the power of traditional modeling of mechanics, coupled with simple, yet well-instrumented experiments, and assisted by DEM. Prabhu Nott first modelled the kinematics and dynamics of a screw feeder, and demonstrated the existence of an optimum flow rate that earlier models had not predicted. He then went on to use DEM to test predictions. In response to IFPRI members comments, he carried out simulations on the role of cohesion. Despite the pandemic, his students completed an experiment that they instrumented with a triaxial force sensor. This revealed a Janssen-like exponential decay between blades, which the model could predict.

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We also witnessed the power of unique instrumentation. Karen Daniels and her students exploited the 2D photoelastic method to calculate the average stress tensor in a shear cell and find its relation with kinematics. Karen showed that the data can be fitted to the non-local rheology framework of Kamrin, et al. However, the principal result is that boundaries are so pervasive that the fitting parameters are not material constants. Karen's candid observations confirm that granular flows are never far from their boundaries. This also suggests that the non-local rheology requires major repairs, particularly on the role of boundaries and the prediction of local solid volume fraction.

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In this context, Prabhu Nott's recent publication of a non-local constitutive model that incorporates dilatancy suggests that a collaboration with Karen Daniels would be fruitful.

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Kit Windows-Yule and Jonathan Seville created digital twins of familiar flow characterization devices, like the Freeman Tech's FT4 and Granutools' Granudrum. This allowed them to emulate the standard

operating procedures of industrial members for fitting DEM parameters, and to test these choices against their own Positron Emission Tomography data. Clearly some of these SOPs worked well, while others didn't. This suggests further work on different particle types and flows, and also on publicizing the standard operating procedures that they developed, perhaps toward an ASME or ISO standard.

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Indresan Govender also exploited unique PEPT instrumentation. He compared the data to an integration of governing equations that adopt the linearized local rheology of Jop, et al. This allowed him to derive a dimensionless number omega to scale granular mixing, which he assumes to be governed by the local kinetic energy of the flow.

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Arno Kwade's group reported results on the role of grinding aid additives in continuous dry-milling and air classification. Empirical data in the ball mill showed that acid and alcohol additives both enhance flowability, but at the detriment of a smaller residence time with continuous operations.

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As a forward look, I would argue that the powder flow portfolio should reintroduce air. Gas-solid flows were an important component of IFPRI, when Roy Jackson and Sankaran Sundaresan were grantees in the 1990s. To that end, we should recruit scientists with wide scientific background such as Olivier Desjardins, Jesse Capecelatro, or Rodney Fox.

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Another example of Olivier Desjardins' scientific bandwidth is his high-fidelity simulations of spray atomization, which were validated against X-ray imaging at Argonne National lab. These simulations could complement the work done by Ashgriz's group on sprays at various viscosities and rheologies. Olivier is also currently validating numerical simulations of capillarity against experiments conducted on the International Space Station.

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This is a partial list of other scientific stars who would make excellent IFPRI grantees. Several of them are regular speakers or attendees of the Gordon Conference on Granular Matter, which our former grantee Nathalie Vriend will chair from June 26 to July 1, 2022. I hope that these dates won't conflict with our own AGM.