1st AXEMA-EurAgEng Conference

"Intensive and environmentally friendly agriculture: an opportunity for innovation in machinery and systems"

Experimental justification of the conveying parameters for the air-seeders

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Plan

1. Problematic of wide width air-seeders

   - ✓ Agricultural context
   - ✓ Technical context
   - ✓ Improvement ways

2. Goals of research

3. Materials and methods

4. Results and discussions

5. Conclusions and further work

   - ✓ Air-seeder conception
   - ✓ Recommendations for air-seeder settings

1. Problematic of wide width air-seeders

Agricultural context:

- Sizeable planes areas
- Short seeding period
- High fuel cost

Technical context:

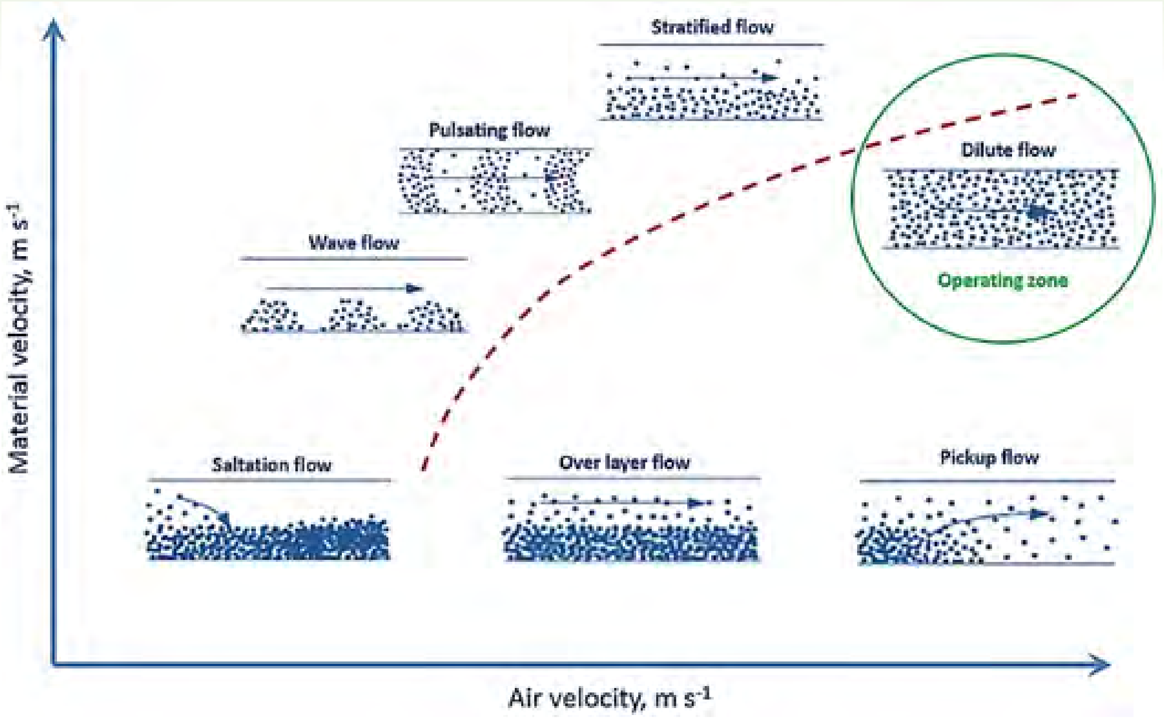
- High energy consumption for seeds conveying
- Low transversal repartition quality
- Incorrect conveying system parameters
- High clogging risk

Technical goals:

- **Reducing or elimination of clogs**
- **Energy economy**
- **Facilitation of the airseeder settings**

1. Problematic of wide width air-seeders

*Source: (*Binsirawanich, 2011; Barbosa et Seleghim, 2003*).*



Flow regimes for air-solid mix as the function or the air velocity

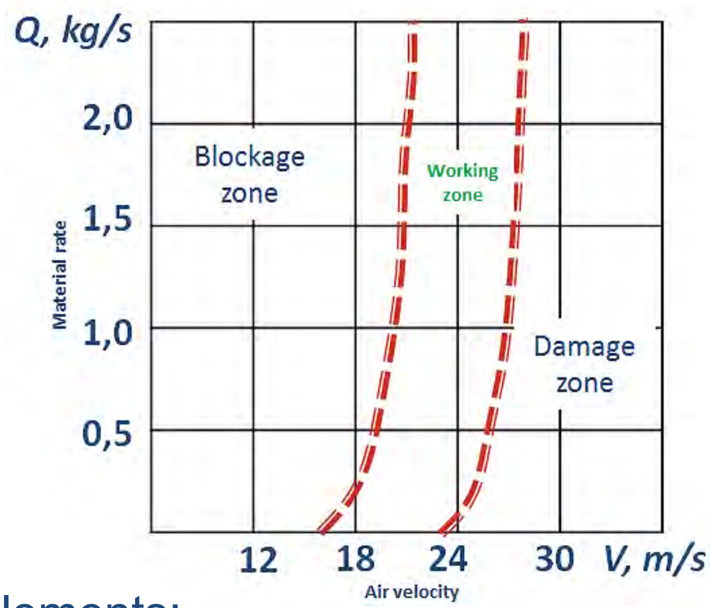
- **Needs in regular seed-flow**
- **Conveying in dilute phase only**

1. Problematic of wide width air-seeders

Physical and agronomy constraints:

- ✓ Narrow working zone of air velocity
- ✓ Problem of the air-evacuation before openers
- ✓ Problem of pressure losses determination
- ✓ Physical proprieties of seeds and fertilizers
- ✓ Poor bibliography sources
- ✓ Difficult theoretical substantiation

Source: (Segler).



Causes of clogging:

- ✓ Slow air velocity;
- ✓ Raw seeds;
- ✓ Slowdown of the flow by the divider manifold elements;
- ✓ Fractures, tightening and sagging of outlet pipes

2. Goals of reseaurch

- Study of the pneumatic conveying in the air-seeders
- Determination of the optimal parameters of pneumatic conveying taking into account the specificity of air-seeders (Namely: range of air velocity and mass flow concentration)
- Generation of the viable data for the conception and setting

3. Materials and methods

Mass flow concentration:

$$\mu = \frac{Q_s}{Q_g}$$

$$\mu = \frac{Q_s}{V_{ast}\pi\frac{D^2}{4}\rho_a}, \text{ [kg/kg]}$$

$$Q_m = \frac{QV_m B}{10^4}$$

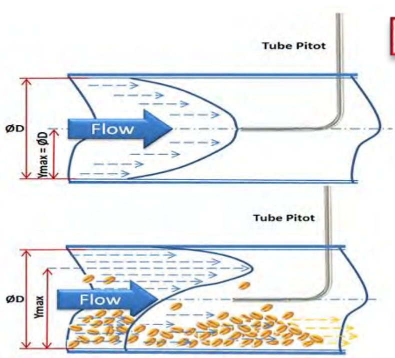
Q_s – mass material rate, in kg/s;

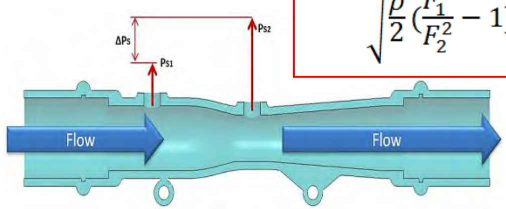
Q_g – mass air rate: in kg/s;

Q'_g - volume air rate, in m^3/s;

ρ_a - volumetric mass density of air

Air velocity measurement:

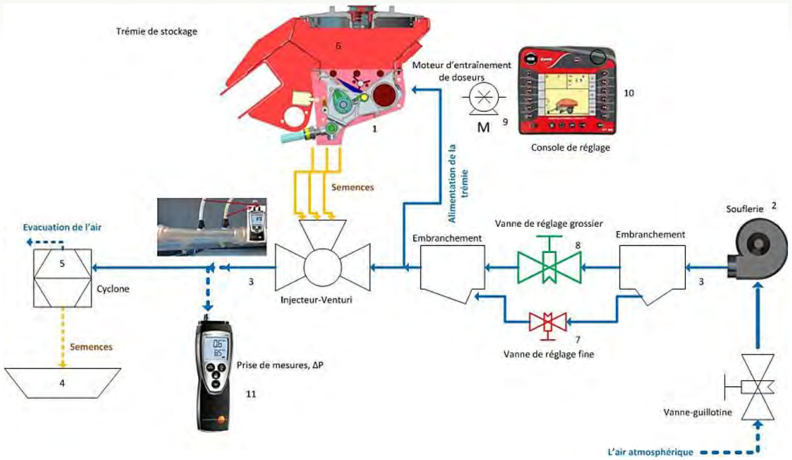




$$\Delta P = \frac{\rho V_2^2}{2} - \frac{\rho V_1^2}{2}$$

$$V_1 = \sqrt{\frac{\Delta P}{\frac{\rho}{2}(\frac{F_1^2}{F_2^2} - 1)}}$$

Experimental setup:



Testing was realized for:

- ✓ Pipe diameters: 20, 25, 30 mm;
- ✓ Wheat, Barley, Starter fertilizers Barley-Fertilizer mixture;
- ✓ Vertical and horizontal conveying;
- ✓ Fivefold measurement

For each diameter and type of grains:

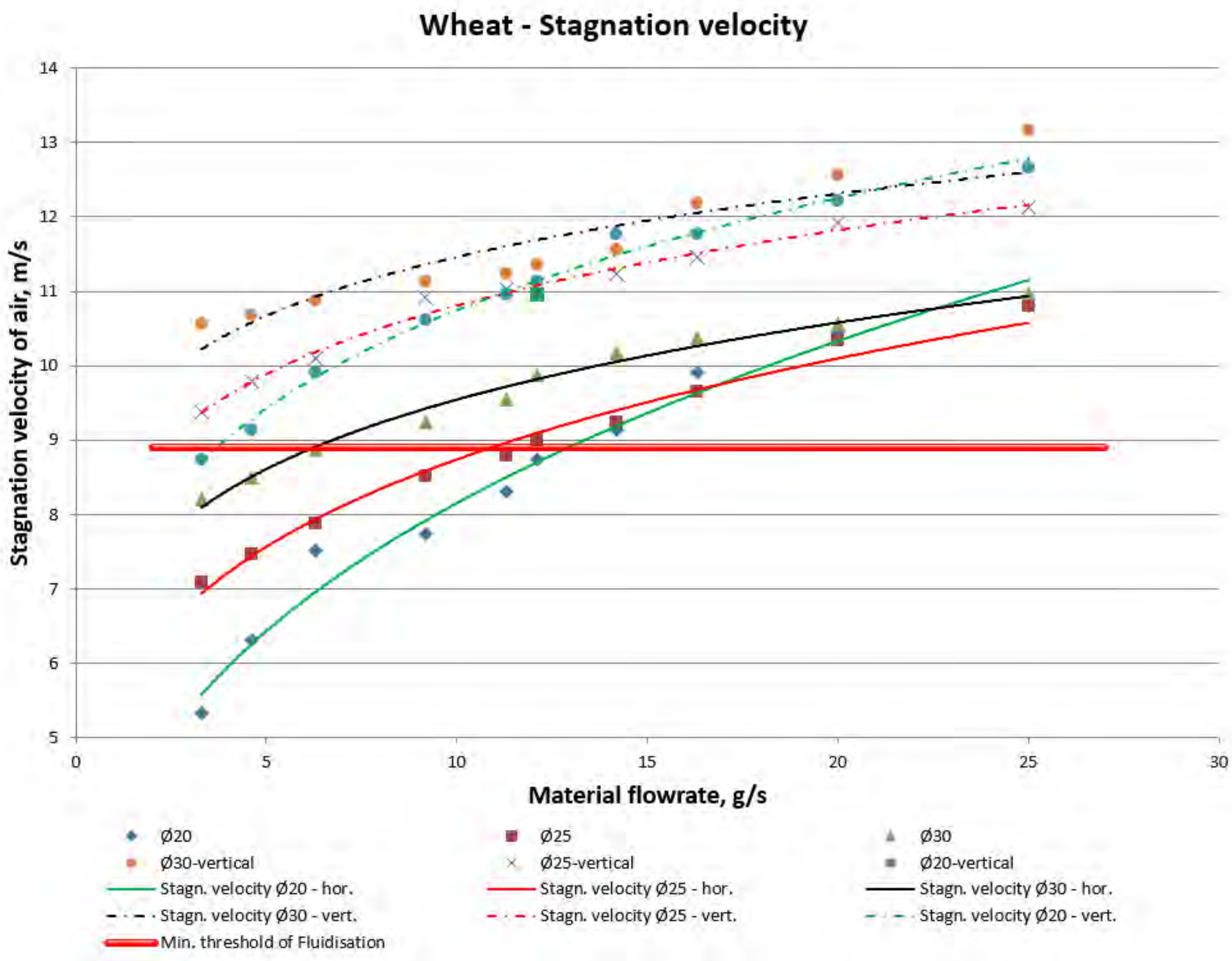
Difference of pressure measuring

Air velocity calculating

Flow concentration determination

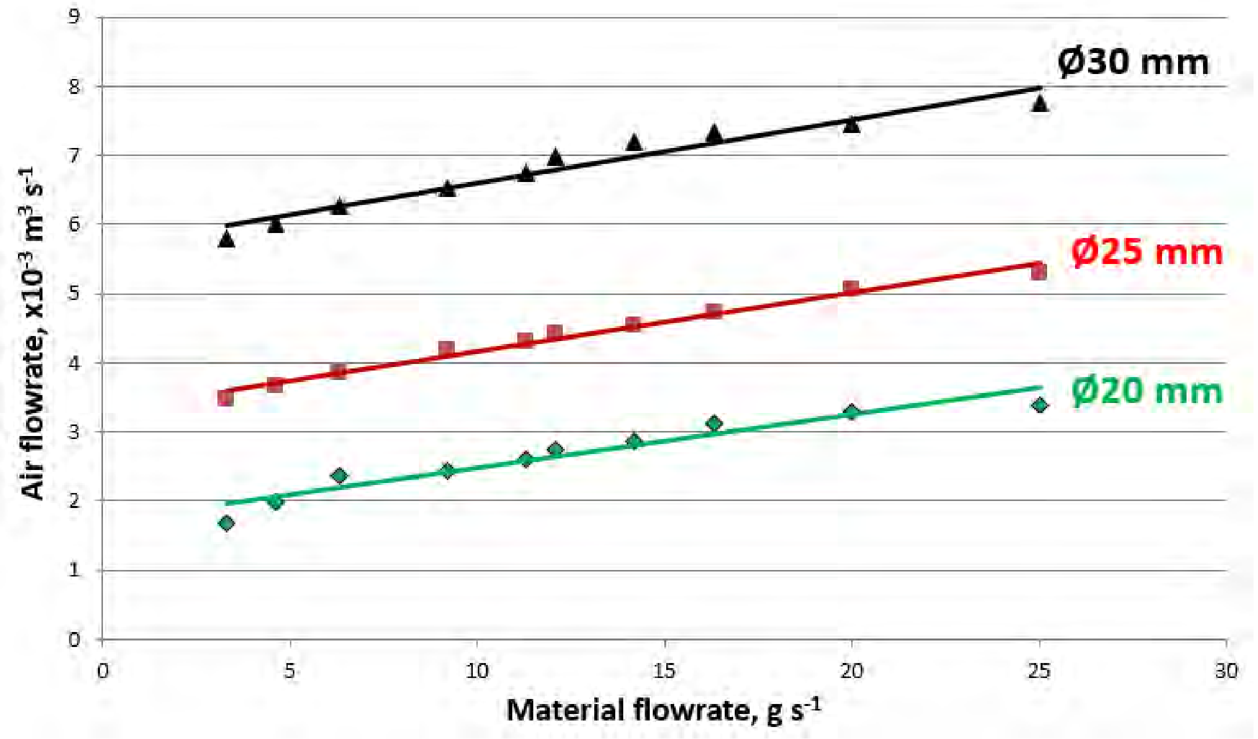
4. Results and discussions

Barley, fertilizers and mixture stagnation velocities:



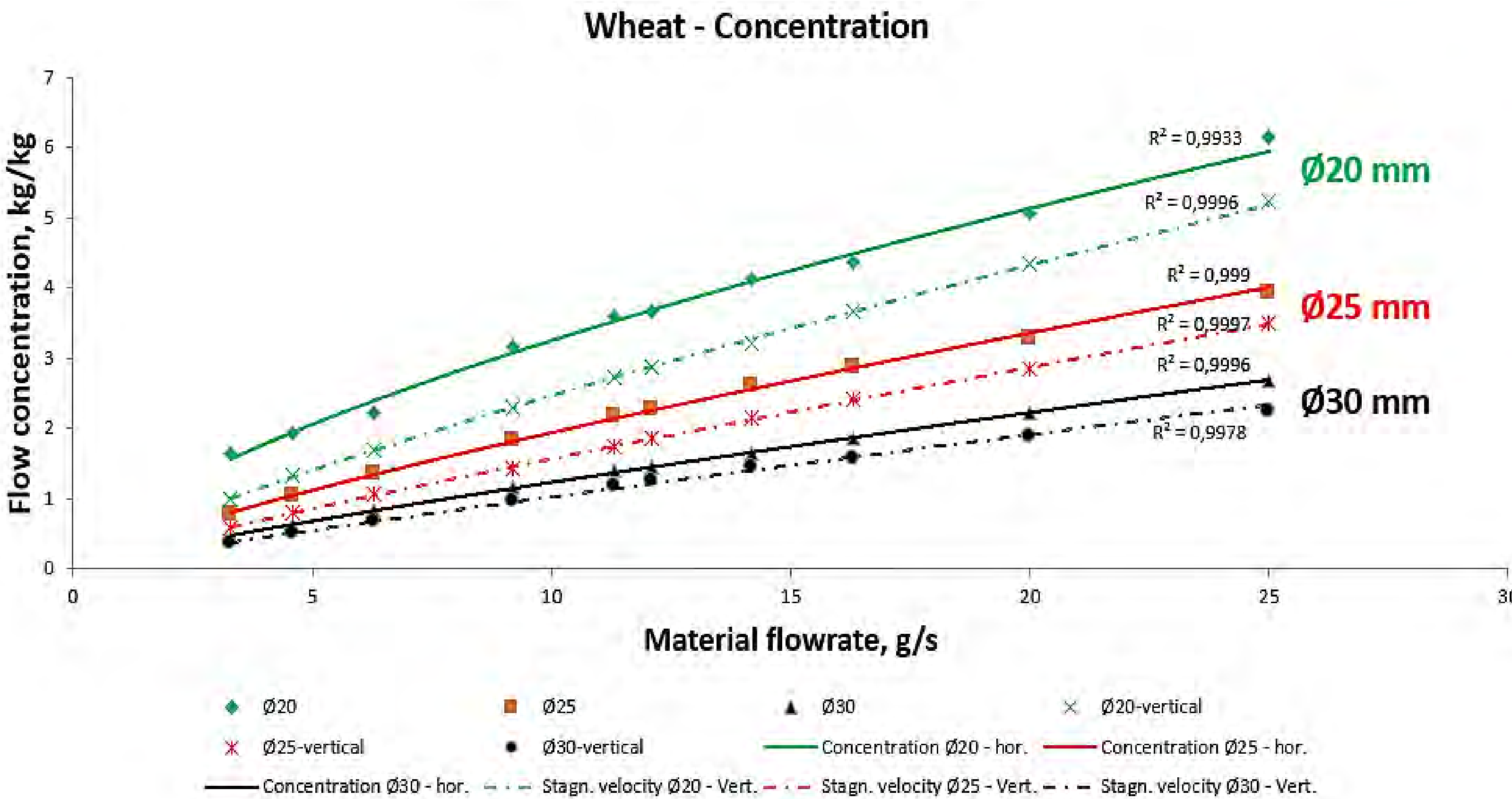
4. Results and discussions

Maximum airflow consumption for wheat



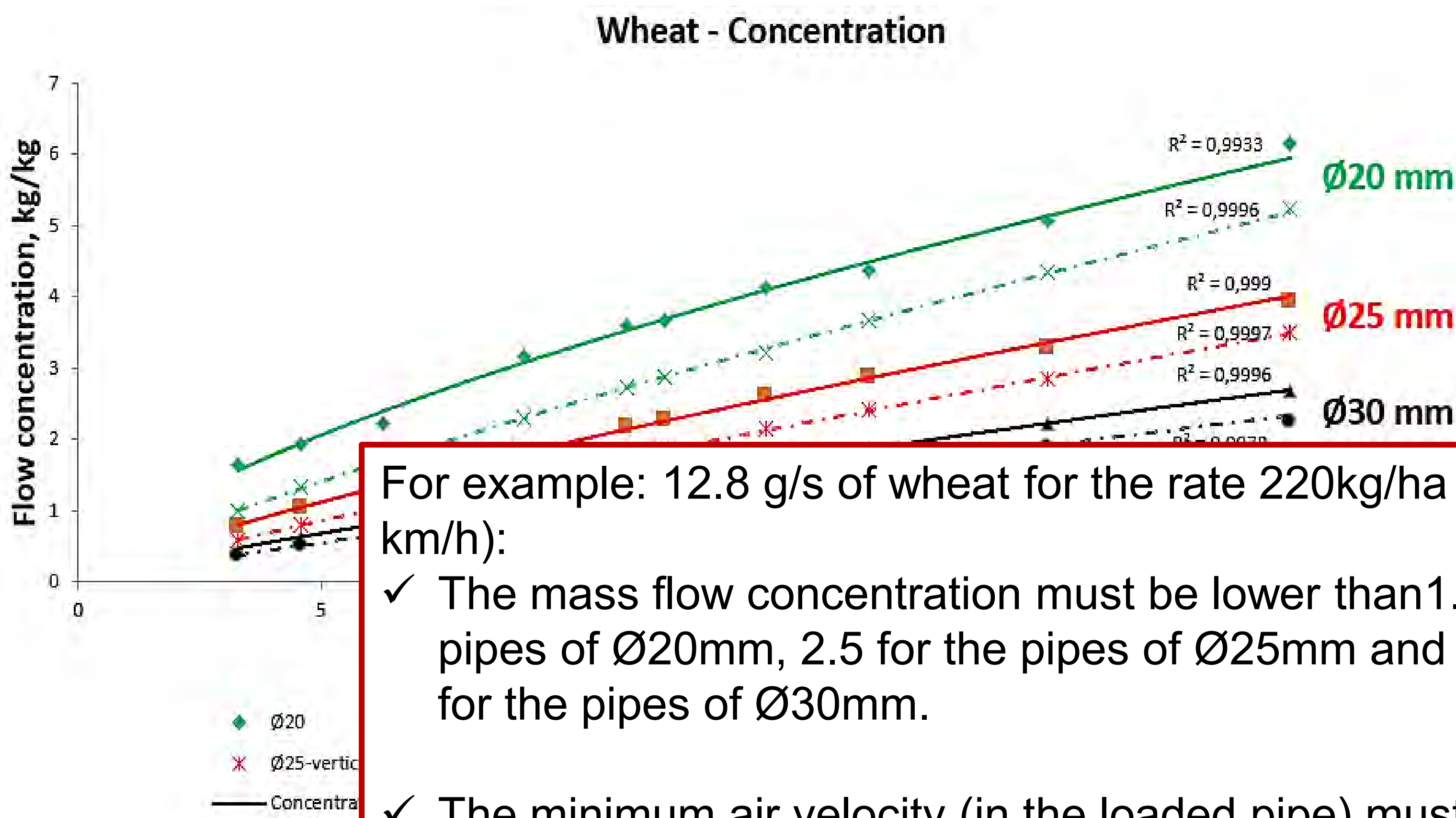
4. Results and discussions

Maximum flow concentration of wheat



4. Results and discussions

Maximum flow concentration of wheat



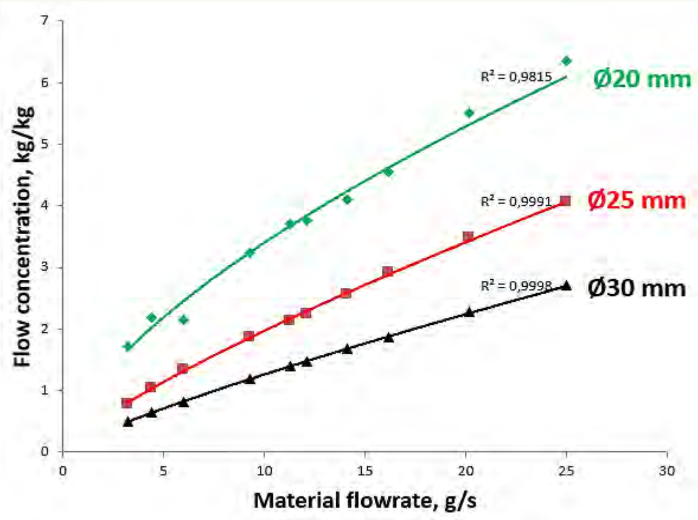
For example: 12.8 g/s of wheat for the rate 220kg/ha at 10 km/h):

- ✓ The mass flow concentration must be lower than1.5 for the pipes of Ø20mm, 2.5 for the pipes of Ø25mm and 3.5 pour for the pipes of Ø30mm.

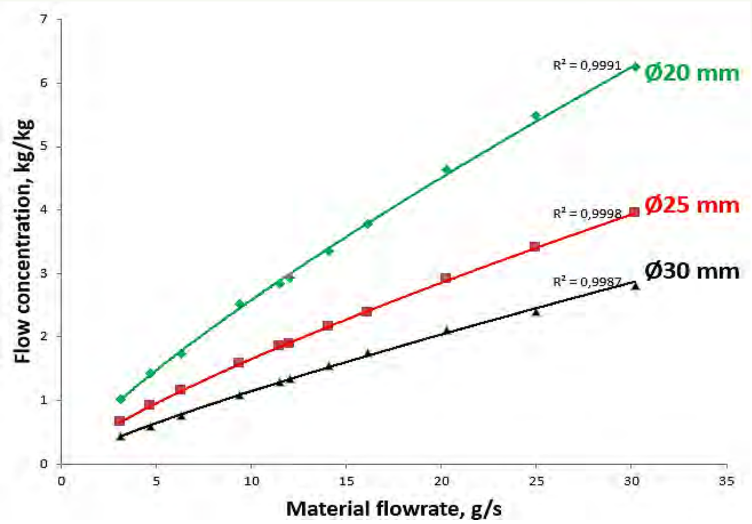
- ✓ The minimum air velocity (in the loaded pipe) must be greater than 11.8 m/s. (Vm=0.817Vmax).
- ✓ In the case of sonde Pitot using this value must be greater than 14.4 m/s.

4. Results and discussions

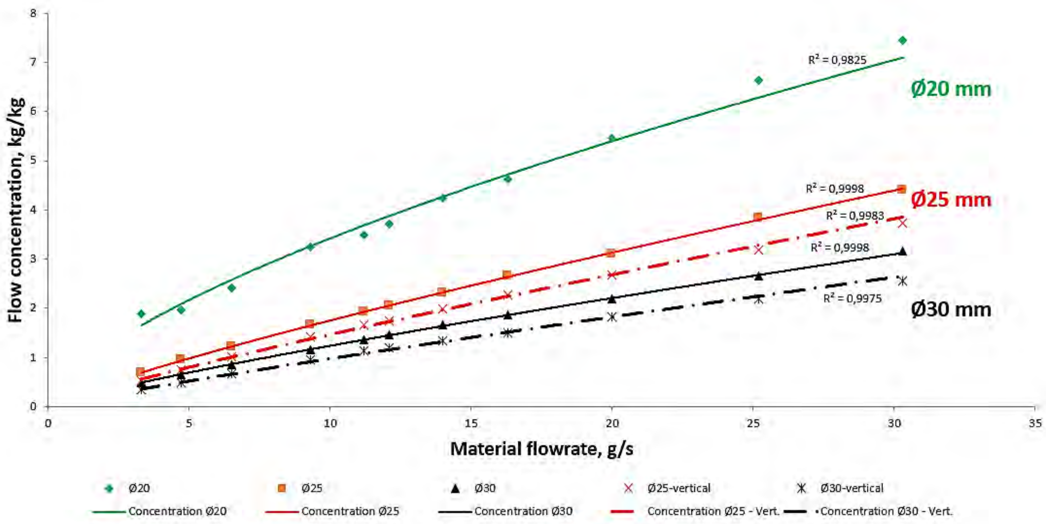
Maximum flow concentration for Barley



Maximum flow concentration for fertilizers



Maximum flow concentration for Mixture



5. Conclusions and further work

- Starting point of design must be the optimization of conveying in the pipes after distribution head. The design of the rest of the conveying system will result from this first step
- An experimental set up was design to obtain experimental values for the maximum flow concentration and the minimum air velocity suitable for pneumatic conveying.
- Design of new sensor system.
- It is recommended to use the pipe sections as lower as possible to favor a homogenous airflow and to reduce the energetic cost of conveying.

5. Conclusions and further work

- Experimental curves of minimum air-velocity can be used to define conditions of conveying for a type of seeds. This value may be 15% higher than the limit of stagnation velocity in vertical conveying for more safety.
- In order to develop knowledge on the conveying of mixtures other experiments could be requested for several proportions of fertilizers and seeds.
- Further development of this experimental set-up could use image analysis in order to correlate pressure measurements and seeds stagnation.
- Same work must be made for other species of seeds.

Thank you for you attention

Any questions?