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Master thesis - *Masterarbeit*

Thesis received: XX.XX.20XX	Workload: 720 h (24 CP)
Submission of thesis until: XX.XX.20XX	Duration: 6 months
First examiner: Prof. Dr.-Ing. D. Schillinger	Supervisor: Tarun Gangwar
Second examiner: Prof. Dr.-Ing. U. Nackenhorst	

Imaging-informed multiscale material modeling of crops

Plant structures are made up of a few basic constituents, i.e., cellulose, hemicellulose, lignin, and pectin. The complex hierarchical organization of these basic constituents at different length scales results in a wide range of highly anisotropic and heterogeneous elastic and strength properties of plant materials, ranging from soft apple pulp to strong structural wood. Advanced microimaging technologies such as transmission electron microscopy (TEM), light microscopy, and computed tomography (CT) enable the qualitative and quantitative description of various hierarchical levels in the plant stem organization.

In this M.Sc. thesis project, the first task is to characterize the hierarchical organization of wheat, barley, and oat with existing chemical analysis and imaging data. The second task is to build a micromechanics-based model of macroscopic strength and stiffness properties for each crop. The model needs to be validated against the already performed bending experiment tests on crop stems. The third task is to perform linear-dynamic analysis on a

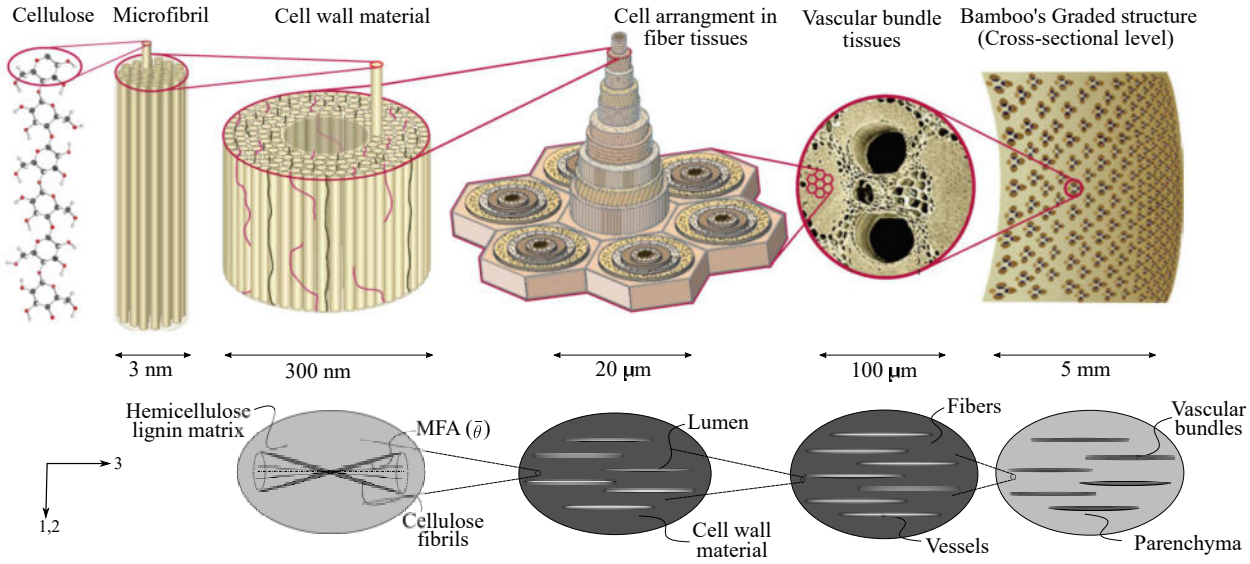

figure 1: Hierarchical structure of a plant and its micromechanical representation.

whole plant for each crop using the predicted material properties. In the final step, qualitative differences between the crops based on the physiological characterization, material modeling, and whole plant mechanical behavior should be evaluated. The results will support the exploration of suitable phenotypes for the crops with improved lodging resistance.

Required knowledge: ...
A background in continuum mechanics and finite element analysis is required. This thesis can be supervised/written in the English language only.

Literature:

[1] Gangwar, T., & Schillinger, D. (2019). Microimaging-informed continuum micromechanics accurately predicts macroscopic stiffness and strength properties of hierarchical plant culm materials. *Mechanics of Materials*, 130, 39-57.

[2] Berry, P. M., Sterling, M., Spink, J. H., Baker, C. J., Sylvester-Bradley, R., Mooney, S. J., ... & Ennos, A. R. (2004). Understanding and reducing lodging in cereals. *Advances in Agronomy*, 84(04), 215-269.