Contained agriculture, enhanced photosynthesis and cell-free biosynthesis - new tools for the bioeconomy

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The presentation will cover three approaches that can contribute to the sustainable and safe production of food, feed and renewable materials, as well as the manufacturing of valuable biological molecules. (1) Controlled Environment Agriculture offers the potential to produce high quality food and feed crops locally all year round, while conserving resources and land and ensuring a reliable supply. We have developed a new vertical farming system, OrbiPlant®, which uses a conveyor belt to reduce operating costs and enables improved and accelerated plant growth. (2) Improving the photosynthetic performance of crops is hampered by, among other things, the low activity of Rubisco to fix CO_2 at high oxygen concentrations. We have developed several strategies to increase the CO_2 concentration or decrease the O_2 concentration in the vicinity of Rubisco, resulting in significant increases in tuber number and biomass in potato. Up to 50% more tuber biomass has been achieved in greenhouse and semi-field trials. (3) Cell-free expression systems allow the production of toxic or difficult-to-produce proteins and metabolites within hours or days. We have developed a cell-free lysate derived from tobacco BY-2 cell suspension cultures for the production of recombinant proteins. This system is remarkably productive, achieving yields of up to 3 mg/mL in a one-pot *in vitro* transcription-translation reaction. Importantly, the cell-free system can be scaled up to multi-litre reaction volumes, enabling the production of gram quantities of proteins and secondary metabolites.