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Development of Novel Approaches to Optimize Crops for Bioenergy and Beyond

Development of highly performant energy-crops is needed to provide sustainable and large resources of biomass to feed our biorefineries and to support cost-effective conversion of the biomass into biofuels and bio-products. Plant biomass is mainly composed of polymers made of fermentable sugars (cellulose and hemicellulose) that are embedded in a robust aromatic polymer called lignin. Recalcitrant to degradation, lignin inhibits efficient extraction and hydrolysis of cell wall polysaccharides and prevents low-cost lignocellulosic-biofuel production. Unfortunately, content and composition of these polymers cannot be drastically manipulated to the same extend in all tissues without causing deleterious consequences on plant productivity. Therefore, technologies allowing precise manipulation of content and composition of various components of plant cell walls should be developed to facilitate the production of cheap and large quantities of fermentable sugars without compromising plant growth. Moreover, engineering plants with complex metabolic pathways or multiple traits is often inhibited by the number of genes that are required to reach the final product. This presentation will highlight our progress in crop engineering. In addition to biomass trait engineering strategies, it will include tools such as in vitro and in vivo DNA assembly methods to stack multiple gene cassettes, promoter libraries developed to support tissue specific expression, and approaches used to support expression strength and precision of one and multiple genes in plants. We are convinced that the development of these tools and approaches will offer new directions to support basic science and the optimization of agronomical and energy traits. They will also provide support to scientists and engineers who are looking at stacking and controlling multiple genes and interested in manipulating endogenous metabolic pathways.