Innovative energy technologies for sustainable food production

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Motivation

Challenges at the food, water and energy nexus stifle socio-economic development in Africa. Food production competes for water and energy, and water provision requires energy. Lack of energy access leads to food product losses during processing and storage, which can be addressed through an integrated approach to energy supply.

Problem Statement

According to the Food and Agricultural Organization of the United Nations (FAO), one in four persons in Sub-Saharan Africa are undernourished. Solutions can only be achieved where interconnectedness of food, water, energy and land are addressed in a holistic manner. Existing studies mostly focus on only two spheres leading to the nexus, e.g. food-water or water-energy. Our purpose is to develop practical and realistic solutions to address the nexus challenge, to enhance the nutritional quality of food in a sustainable, and energy and water self-sufficient manner using a multi-disciplinary approach.

Methodology

A consortium including SA higher disadvantaged institutions (HDIs), African universities, SMMEs and international specialists was formed, bringing together process- and wind energy engineers with food, water and agricultural scientists to develop solutions where sustainable energy generation and water reclamation can be integrated into food production. A broad cross section of the food production value chain will be addressed, from primary production to minimising post-harvest losses. The emphasis will be on developing practical and implementable solutions supported by techno-economic and life-cycle analysis. Key technologies will include the development of hybrid wind energy/biogas systems where waste can be recycled and water reclaimed, supplemented by the wind energy to facilitate favourable energy balances.

Results

Four key technologies were identified. (i) Protein from fly larvae cultivated on “clean” substrate, such as treated lignocellulosic biomass (LCB) offers a rich nutrient source for human consumption. Methane from anaerobic digestion (AD) of processing waste offers energy and reclaimed water, whereas wind supplies energy. (ii) Arabinoxylans, their oligomers (AXOS) and ferulic acid from LCB can be used to enrich bread with fibre, prebiotics and antioxidants with energy for plant operations and water recycling supplied through wind and AD energy. (iii) Aquaculture/hydroponics offers a classic nexus intervention where fish waste offers energy and nutrients for plants, water is purified through AD and heat is provided through wind and AD. Marine aquaculture will also be addressed through pond cultivation of seaweed. (iv) Cold storage solutions will be developed where renewable energy will service cooling facilities to preserve fish, dairy and abattoir products, especially in rural African settings and during transportation.

Conclusions

Integrating wind power into the food-water-energy nexus demonstrates the true value of “Wind Power Without Borders”. Several benefits will result, including socio-economic development and decreased water wastage and pollution. Substantial opportunity is presented to deepen the Regional Leaders (RLS) network, with further links to the African Research University Alliance (ARUA).