Agrivoltaics affect on Water–Energy–Food Systems nexus: agriculture and rural entrepreneurship

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Reducing greenhouse gas emissions is a global challenge. Innovative agrivoltaic systems that combine agriculture and solar energy production is one set of the solutions to reduce these emissions and contribute towards food-system transition and enhancing rural entrepreneurship. Current research on agrivoltaics reveals a lack of knowledge regarding their effects on agriculture and Food-System Transitions. While agrivoltaics have been recognized for their potential to reduce water consumption through microclimatic modification and shading, and positively affect rural entrepreneurship, empirical evidence quantifying these impacts remains scarce. Such studies are essential to advance food-system transition. This research aims to study the potential of agrivoltaics and its affects on agricultural production, water-use efficiency, food-system transitions and rural entrepreneurship.

The study focuses on agricultural region of Goriška Brda, known for quality viticulture. We used Geographical Information System datasets (e.g. land use, digital elevation models, solar radiation), remote sensing data, irrigation requirements per crop type, and energy production, to assess affects of agrivoltaics on crop production. Literature review on scientific and grey literature was used to assess the affect of agrivoltaics on rural entrepreneurship. These datasets enabled a spatially explicit assessment of agricultural and energy system interactions within the study area. We created a model of agrivoltaics integrated in vineyards in the study area. The model included 10% coverage of all vineyards using solar panels over vine with east-west orientation and 60% transparency.

Preliminary results suggest reduction of crop water demand (up to 20%) and energy production of 1.064 GWh / year, roughly covering energy demand for 302 households in Slovenia. The yield quantity is expected to increase up to 20%. Moreover, agrivoltaics affect also quality of grape, by prolonging growing season and consequentially increasing grape components (e.g. acidity, anthocyanins). The study also revealed positive increase of rural entrepreneurship by increasing regional economy and vitality of the rural area.

Agrivoltaics is an emerging approach showing promise for energy and food production while mitigating conflicts between them. It enhances crop quantity and quality, water efficiency, contributing towards food-system transitions and enhancing rural entrepreneurship. Overall, agrivoltaics showed the potential to advance sustainable, climate-resilient farming and positively impact on food-system transitions.