Agri-PV in Global South for Food Security

Student

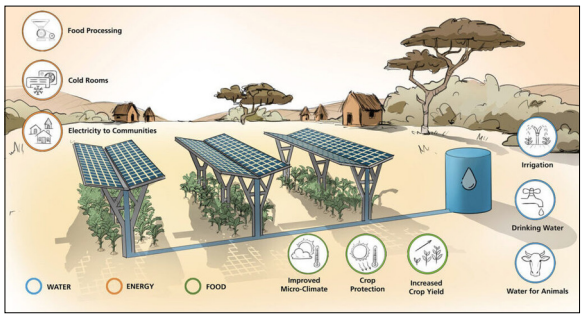
Billal Purivatra

Introduction: Agri-PV (APV) technology represents a novel approach to the integration of agricultural utilisation and electricity generation from Photovoltaic (PV) systems [1]. This technology is becoming increasingly pertinent in addressing several pivotal challenges of our era. The Photovoltaic panels (PVP) provide protection for the underlying plants against extreme weather conditions, such as heavy rainfall, hail, and intense solar radiation. This can lead to a stabilisation of crop yields. The strategic positioning of PVP can facilitate the formation of a microclimate beneath the plants, which can prove advantageous for specific plant species and for PV yields. It is anticipated that Agri-PV will become an increasingly significant phenomenon, particularly in the Global South, where issues pertaining to food and water scarcity, as well as water management, are of paramount importance.

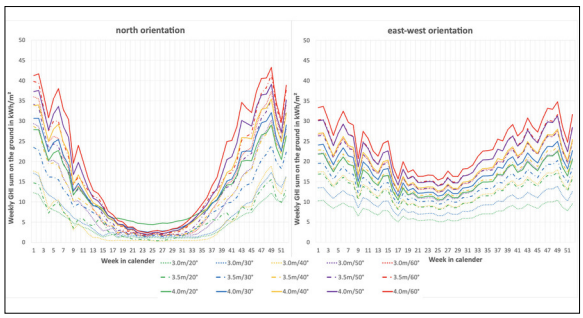
Approach: When optimising APV systems, it is important to control the limiting resource, namely light, in such a way that the plants can make optimal use of the reduced light supply under the PVP. Two principal methods of optimisation exist. Firstly, the shading of the plants can be influenced by modifying the density of the PVP (e.g. mechanical tilt and row spacing adjustment). Secondly, the optimisation of APV systems may be achieved by improving the understanding of the plants reaction to light (e.g. light saturation point). At a certain point, the ability of plants to convert additional light into photosynthetic energy is exhausted. The point at which light saturation occurs is decisive for the suitability of a plant species for APV systems. The impact of shade on crop yields has been demonstrated to result in slowed growth and reduced overall biomass production at maturity.

Conclusion: The simulations in PVSyst for mechanical constructions with different orientations demonstrated a notable discrepancy between the north and east-west orientations at varying row spacings (3m to 4m) and tilt angles (20° to 60°) of the PVP [2]. The simulations were done for Marikana, South Africa and demonstrate that orientating the PVP in an east-west direction facilitates a more uniform distribution of global horizontal irradiation (GHI) at plant level and enhances growing conditions, particularly during the South African winter months, due to the presence of sufficiently high GHI values [2]. In contrast, a northern orientation results in a slightly higher energy yield over the year. However, this may result in a loss of yield for plants due to an uneven distribution of radiation over the year, particularly during the winter months [3]. Furthermore, the proportion of direct normal irradiation (DNI) is minimal, particularly during the winter months when low GHI values are also observed. The temperature difference under the shaded PVP only leads to a slight reduction in soil temperature compared to an open field. It can be stated that the average daily temperature of the plants in the shade does not show any significant deviation from the unshaded situation due to the sufficient air circulation. Consequently, the growth rates are very similar compared to an open field. The economic efficiency of an APV system is largely guaranteed by the energy fed into the public grid, such that potential losses in agricultural yields are more than compensated for. It is important to note, that air pollution from nearby platinum mines and wood burning has the potential to reduce GHI values and, in turn, influence yields.

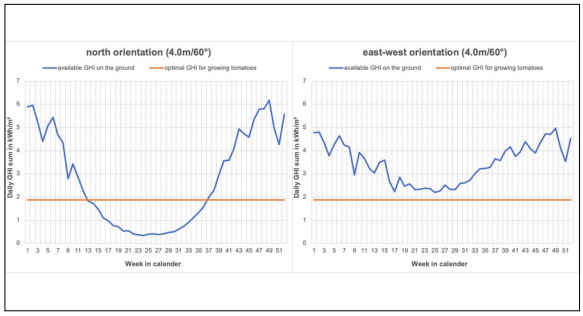
[1] Illustration of an Agri-PV system
maysunsolar.com



[2] Weekly GHI sum on the shaded ground with different row spacing and tilt angle for a north and east-west orientation
Own presentment



[3] Comparison of available daily GHI between the north and east-west orientations with tomatoes as a crop
Own presentment



Advisor
Evelyn Bamberger

Subject Area
Electric solar technology

Project Partner
Mike Howard, Horizon Environmental, South Africa