UNIVERSITI TEKNOLOGI MARA

THE POTENTIAL OF AGRIVOLTAIC SYSTEM IN MALAYSIA: ASSESSMENT ON MICROCLIMATE, SOIL PROPERTIES AND SELECTED CROP RESPONSES

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ABSTRACT

Solar photovoltaic (PV) has grown a lot over the years, which has led to land competition between using PV to make energy and growing food to meet rising demand. As a result, agrivoltaic systems have become a promising way to grow crops and produce electricity at the same time. This research studied the microclimate properties and soil properties effects in the solar park at Pahang and then examined the feasibility of an agrivoltaic system by evaluating the crop responses at Melaka. We measured photosynthesis active radiation (PAR), light intensity (LI), relative humidity (RH), air temperature (AT), and wind speed (WS) in outskirt panels, under panels and row between panels at three distinct locations: the highest point area, moderately inclined area, and the lowest point area. We also collected soil samples for chemical and physical properties analyses. We found that PAR, LI, and WS remained low beneath the panels at all locations. Interestingly, no significant difference in AT was detected at different treatments. The accumulation of organic matter, moisture content, and soil bulk densities showed similarities between different treatments irrespective of locations. Soil infertility is reflected by low pH, CEC, exchangeable bases, and available phosphorus. Furthermore, almost no carbon, sulphur, or nitrogen was found in the results. On the other hand, we observed the growth responses of Okra, eggplant, green spinach, Brazilian spinach, water spinach, Chinese kale, Chinese cabbage, and pennywort under different shading zones like those attributed from a solar panel to determine the growth responses of selected crops. As expected, the light limitation affects the growth of the crops. However, we inferred that okra, eggplant, Brazilian spinach, and pennywort can be implemented in the agrivoltaic system as it was found that the crops planted under the area of the highest elevated panel were able to meet the market's standards. Besides, the other four species of leafy vegetables are more suitable to be grown in the row area. These results suggest that the row area can be the best place to cultivate green leafy vegetables. Therefore, although our solar farm was built close to the ground, it is possible to produce vegetables, and this study may pave the way for the simultaneous generation of food and energy in Malaysia and other Asian countries.

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CHAPTER ONE
INTRODUCTION

1.1 Research Background

Many achievements have been made throughout the years since we as a nation entered the millennia. However, one of the biggest concerns worldwide is the escalating human population (7.7 billion) and increasing energy demands to accommodate the population rise (Calvert & Mabee, 2015; Marrou et al., 2013). At the same time, potentially arable land to support housing development, energy production, and food production has become more limited. The depleting supply of fossil fuel has also prompted other alternatives such as biomass from oil palm and soybean to become substitutes for energy (Hoogwijk et al., 2003). However, the land area that is needed to supply as much energy as fossil fuel will be more than the cultivated land by food crops across the globe (Dupraz et al., 2011). The competing interest of food for energy and consumption will result in the rise of food prices, thus severely impacting the less developed countries. A similar situation had already occurred in Mexico in 2008, when corn prices surged due to increased demand for ethanol in the US market. Henceforth, concerns about the influence of energy crops on food security and availability are felt globally (Nonhebel, 2005).

In order to alleviate the problem, solar photovoltaic (PV) has been introduced since it has the highest potential to generate power among other renewable energy. The installation of PV arrays has greatly increased in recent years due to the fact that it is a clean energy source with no carbon footprint (Armstrong et al., 2015; Pogson et al., 2013). However, the most significant disadvantage of solar power plants is that they require a large amount of land (Fairley, 2015; Weselek et al., 2019).

Thus, it is suggested to combine solar PV arrays and crops on the same land unit at the same time, known as an agrivoltaic system, in order to resolve the issue (Dupraz et al., 2011). Agrivoltaics, also called agrophotovoltaics, is the simultaneous use of land for agricultural purposes and the production of solar photovoltaic electricity (Abidin et al., 2021; Dinesh & Pearce, 2016; Santra et al., 2017). The first comprehensive agrivoltaic farm experiments were recently carried out in France in 2013(Marrou et al., 2013). Interestingly, Malaysia is one of the largest solar panel manufacturers in the