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Integration of solar dryer technologies in high value herbal crops production for Malaysia: pathway for a sustainable future

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Abstract

This paper embarks on the evolution of green economy approach to support the increasing food commodity expenses by adapting Solar Photovoltaic (PV) as the suitable renewable energy technology for Natural Resource Management (NRM). The crops for cash trend and continuously decreasing market price in solar technologies are highlighted with strong effort by Malaysian Government through Renewable Energy (RE) policy and National Key Economy Area (NKEA). Reviews on the benefits of solar dryer technologies in crop production and agro-business are presented with highlights on high value herbal crops (HVHc) and some potentials of high-performance solar dryer technology.

Introduction

Poor utilization and management of natural resource especially crop-based industry can be addressed by promoting the Natural Resource Management (NRM). There are various approaches towards this concept which depends heavily on the economical resources, political stability and human capital. Stakeholder analysis is one of the factors to be considered with regards to the natural resource policy analysis and formulation. Foo (2013) suggested that researchers in the scientific community should contribute in the efforts to achieve sustainability through the practices of skills, consultancies, trainings, knowledge sharing of the environmental challenges, and assist to spearhead a multidisciplinary of technical solutions. In this sense, Malaysia, a developing country endowed with its rich natural resources and diversity recognizes the need to adopt a sound developmental framework to transform the country's educational landscape into a high quality and excellent level creating a pool of highly competent knowledgeable workers.

Recently, in most of developing country, adaptation of green technology towards green economics becomes very important aspect as to ensure sustainable economic growth (Gemmell, Lloyd, and Mathew, 2000; Reardon and Barrett, 2000; Suhariyanto and Thirtle, 2001). Agriculture is a proven driver of transformational change and by strategically applying science and technology in agricultural, communities can improve their livelihood, thus, helping to enhance the economic growth of the country (World Bank, 2008). Both food self-sufficiency and export crop promotion strategies can ensure adequate food supply thereby improving food security and nutrition needs of households in the extended time period. Expanding crops farming induce production of food crops though issues of environmental damage is still unsolved (Barrow *et al*., 2010). Sustainability of agricultural development efforts can be made by policy-led production and modify certain policies in support of production for export. Some issues towards sustainable agriculture in developing countries as follows: outward-looking development: cash crop allows improved factor

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utilization in both the short (exploitation of comparative advantage) and long terms (specialization, economies of scale, "educative" effects and greater x-efficiency associated with higher levels of ex-change); vent for surplus: the idea that increases in output can be stimulated by the emergence of effective demand; comparative advantage: maximizes the investible surplus for maximum long run growth; instability: the issue of marketable risk of cash crop products thus carries along production risk; terms of trade: an idea of changing comparative advantage which takes into account movement of prices, productivity and employment; surpluses; and questions arising on usage of surpluses in real-case basis i.e continuous investment for growth, diverted to foreigners or wasted on luxury consumption.

This paper embarks on the evolution of green economy approach to support the increasing food commodity expenses by adapting Solar Photovoltaic (PV) as the suitable renewable energy technology for Natural Resource Management (NRM). Evidence in empirical studies food pricing have shown phenomenon of continuous inflation which creates macroeconomic turbulence and thus, significantly contributes to overshooting of goods price and rising cost of living.

Urbanization through ecological economics

Steady economical growth and rapidly increasing human population transform suburbs area into urbanized settlements with industrial clusters. This phenomena is further stabilized by the ecological economics concept which is generally refers to standard approach in adapting technology and innovation in agriculture process to enhance production profitability, improve food safety and significantly reduce negative social and environmental impacts (Blazy *et al*., 2011; Kasim *et al*., 2013; Gendron, 2014). The concept also reflect to a comprehensive review on the integration of logarithmic transformation in multiple discipline rests on an inadequate understanding of dimensional homogeneity and nature of empirical modelling in applied sciences thus addresses the complex problems in synthesizing ecological economics (Baiocchi, 2012). Spash (2013) commented a recent article by Hoepner *et al*. (2013) on the definition of ecological economics by stating that the scope of this subject are much broader in sense heterodox field of ecological economics outcomes are from interdisciplinary works from mainstream economics.

The crops for cash trend have direct relationship towards ecological economics referring to the integration of knowledgeable urban people with profitable agro-business. Cash crop which is commonly known as commercial farming refers to any plants in the commodity market that is commonly consume and easily exported to return handsome profit and income diversification (Govereh and Jayne, 2003; Mertz *et al*., 2005). Some examples of cash cropping activities and issues of its development in Malaysia are explained further by Lam *et al*. (2009); Mohammed *et al*. (2011) and Wadley and Mertz (2005)

High value herbal crops (HVHc): the way forward

Malaysian Government promotes the National Key Economic Areas (NKEAs) which is one of the elements outlined under the Economic Transformation Programme (ETP) in 2010 as to boost economic growth after the 2006 crisis. There are twelve NKEAs of selected economic sectors that provide opportunities for the private sector to guide Malaysia towards a high-income status and global competitiveness in order to achieve sustainable economic growth. The NKEA sub-sectors of agriculture focused on the potential to achieve high growth sectors including aquaculture, herbal products, seaweed farming, fruits, vegetables and bird nests. The program seeks to improve the people's quality of life and strengthen agri-businesses via raising agriculture productivity and nurturing agriculture entrepreneurs which focuses on uplifting local communities. Through large funds initiatives, this effort also contributes to productivity gains in stimulating the economy. In 2013 alone, the ETP / Entry Point Project 1 (EPP1) contributed RM7.4 billion to the Gross National Income (GNI) which creates 29,373 new employment opportunities and driving RM8 billion worth of investments.

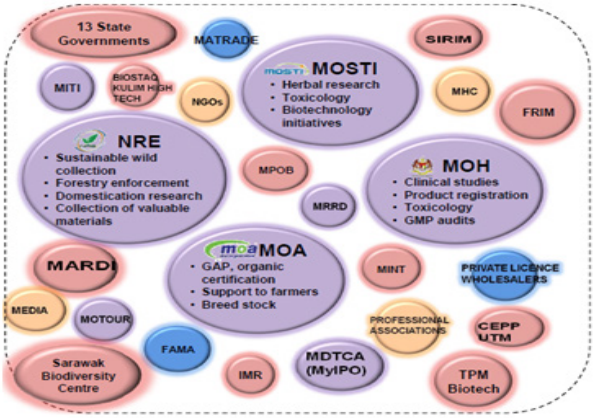

Figure 1. Road-maps towards herbal development council in Malaysia. Source from http://www.moa.gov.my

The EPP1 program enhance dietary and herbal supplements through standardized product quality assessments and marketing strategy to capture the

increasing global demand for high-value herbal supplements and remedies. Strong and continuous initiatives through the Herbal Development Office (HDO), Ministry of Agriculture Malaysia projects the future strategic milestones and way-forward for herbal products development as shown in **Figure 1** thus smoothes their path on creating the Herbal Development Council (HDC). There are about 25 agencies to monitor, regulate and enforce the herbal industry.

Several Herbal Cultivation Parks (HCP) has been in operation since 2011 to ensure sufficient supply of raw herbal material for R and D and clinical trials before mass-production. The targeted high value herbs for Malaysia are described in **Figure 2**.

Figure 2. Selected herbal plants for EPP1 program. Source from http://www.moa.gov.my

The selection of high value herbs is generally based on high demand in Malaysia's mega bio-diversity resources, current market potential and actively on-going research on medicinal purposes.

Agro-solar technology integration in Malaysia

Renewable Energy (RE) has captured the attention of leaders in developing countries especially tropical Malaysia. The Malaysian government continuously strives and strengthen five important trust of appropriate regulatory framework, conducive RE business environment, intensive human capital development, enhancing Research and Development in RE and implementing RE advocacy program for her long term goals within the framework of Malaysia Plan (2021–2025) (Chua and Oh, 2012; Mekhilef *et al*., 2012; Muhammad-Sukki *et al*., 2012). The solar energy potential in Malaysia by the year 2030 is estimated to reach 1,370 MW. The penetration of Solar PV technology in most of the economic sector blooms through the Fit-In-Tariff (FiT) Enactment of the Renewable Energy (RE) and Sustainable Development Authority of Malaysia (SEDA) Bills in 2011.

Detail review of current state and future prospect of solar energy application in Malaysia by Mekhilef *et al*. (2012) highlights the importance of enhancing PV market through research and development, widespread of RE knowledge in each school level, strong government policy and effective role by mass media as a continuous effort in promoting solar energy as the best alternative for future energy generation. This statement was further supported by domestic researchers Muhammad-Sukki *et al*. (2012) and Seng *et al*. (2008) where the annual energy output for PV-rooftop and PV-facade system shows convincing electricity generation (in kWh/KWp) and the kWp PV pricing (in MYR) shows continuous decreasing slope since 2005. Harvesting the abundance solar resources can be derived in three main categories as highlighted by Abdul Hamid *et al*. (2014) which is in solar thermal system, Photovoltaic (PV) system and Photovoltaic-Thermal (PV/T) system and the team concluded that the PV/T system produces magnificent results by 50-80% as compared to single PV and thermal collector.

Solar heater application in agro-industry has been widely accepted and appreciated despite some issues of overheating, cracking, vermin and dust contamination, rewetting during sudden rains, predation by animals and vandalism by humans which mainly due to lack of control and environmental factors Pirasteh *et al*. (2014); Tyagi *et al*. (2013); Mustayen *et al*. (2014) conducts comprehensive reviews on solar heater for agro products and defines five types of solar-based dryers as follows: a) Direct solar dryer (box or cabinet type with transparent cover to reduce heat loss and aeration to remove water evaporation), b) Indirect solar dryer (solar collector directs sun's heat onto dryer cabinet), c) Mixed-mode solar dryer (sun's ray enters collector lustring inside chamber- black inner surface trap heated air for drying), d) Natural convection solar dryer (consists of solar collector, transparent sheet and drying unit with shading, and e) Forced convection solar dryer (implies electricity to operate fans)

Some of the high-performance dryer for agro-PV projects are shown by Aritesty and Wulandani (2014) for Rack Type-greenhouse Effect Solar Dryer for Wild Ginger in **Figure 3**(a) and solar-assisted spouted bed drier in drying pea in Ankara, Turkey by Sahin *et al*. (2013) as shown in Figure 3(b). Based on the rapid PV technology enhancement and the increasing demand of herbal-based products in the world market, the idea of agro-PV integration comes smoothly into the picture. It is proven that by adapting PV dryers, the process can be done in an environmental friendly condition without using any means of fossil fuel

Figure 3(a). Rack-type solar dryer

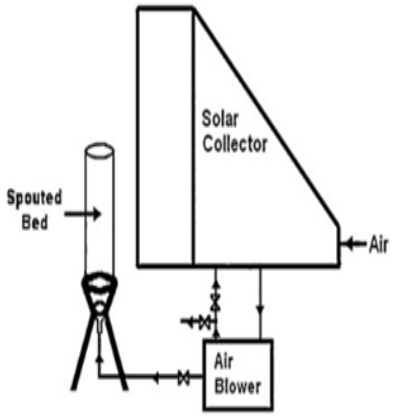

Figure 3(b). Solar spouted-bed dryer

sources and the output of dried raw material can be upgraded in terms of duration, capacity and quality furthermore the pricing of PV technology maintains in decreasing pace over the years.

This condition projects a strong potential in herbal products based on the low-moisture content of raw plants (either from leaves, nodes and roots) as compared to other cash crops in the market. Further field analysis on the Return on Investment (ROI) and Life Cycle Analysis (LCA) for potential high value herbal crops (HVHc) utilizing Solar PV-dryers are suggested in the near future as to support this hypothesis plus continuous research in PV glazing as greenhouse and high-tech DC motors for irrigation system.

The continuously decreasing market price in solar PV technologies is highlighted with strong effort by Malaysian Government through RE policy and NKEAs. Malaysia as a developing tropical sunbelt country reflects greater interest in agro-technology adaptation as means of sustaining food crop supply and demand thus, consistently boost their economic growth for years to come. Critical reviews on the benefits of Solar PV dryer technologies in crop production and agro-business are presented with some economic perspectives.

Conclusion

A comprehensive review on High Value Verbal Crops (HVHc) and high performance Solar PV dryer technology are presented. The new concept of Agro-PV integration in herbal plants for Malaysia blooms the idea of ecological economics within renewable perspectives. Strong economical potential based on the abundance of bio-diversity resources and decreasing PV pricing in the world market are the backbone for mass production. The integration of these two elements projects high demand of herbal product outcomes within eco-friendly facilities. Further field analysis on the Return on Investment (ROI) and Life Cycle Analysis (LCA) for potential high value herbal crops (HVHc) utilizing Solar PV-dryers are suggested in the near future as to support this hypothesis plus continuous research in PV glazing as greenhouse and high-tech DC motors for irrigation system.

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