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Sustainable Influence on Tidal Lowland Crop Farming: A Research Strategy

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Abstract: *Most of the vast potential of tidal lowlands including crop production. Though, tidal lowlands also encompass numerous ecosystem utilities that inhibit them from exploitative practices. Hence, tidal lowland operation for crop production have a duty to consider measures to attain sustainable development goals (SDGs) in one hand. In the other hand, SDGs ought to ensure the sustainable practice of tidal lowlands. This paper intends to assess the sustainability of crop production in tidal lowland as it support the achievement of SDGs, which tends to eradicate hunger, achieving food security with good nutrition, and improving sustainable agriculture. These goals essential to be achieved in 2030 by endorsing sustainable crop production systems, applying through agricultural practices, production accumulation and productivity, and at the same time maintaining environmental and tidal lowland ecosystems. So, this paper will review three major aspects as follows: Method to produce crop in climatic condition, Ideal Crops for Tidal Lowland, and Influence of Climate on crop Quality. This paper is anticipated to yield sustainable processes of crop production in tidal lowlands to contribute to the accomplishment of sustainable development goals (SDGs).*

Key words: *Crop farming, sustainable development, tidal lowlands*

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Introduction

It is believed that Oryza Sativa is associated with wetland, humid climate, though it is not a tropical plant per se. It is probably a descendent of wild grass that was most likely cultivated in the foothills of the far Eastern Himalayas (farmer.gov.in). Nevertheless, as detailed in the Malaysia Productivity Blueprint[4], the productivity of farmers in the agro-food sector is plagued by issues such as: a) Insufficient focus on value-adding activities and disconnections along the value chain; b) Multiple small producers with low levels of productivity; c) Issues with quality and standards across the subsector; and d) Low adoption of technology and modern farming practices (Khazanah, 2018).

More so, in a study of world Bank statement, the Malaysia paddy industry is unstable and unprofitable Siwar 1995. Hence, the continuation of Malaysia to commit in sustainable development goal (SDG) approach toward finding a balance between the need and the paramount development in to the environment. The commitment of the country has been indicated as a (United Nation) UN-member country by the signing of the related agreement of the SDG. The Malaysian Government is responsible to end hunger, achieve food security and improved nutrition and promote sustainable agriculture UN," Goal[2]. The bull's eye in the SDGs document is to confirm a sustainable crop production scheme and implement buoyant agricultural practices that intensification production and productivity and assist in safeguarding the environment and ecosystem in 2030. The Government is responsible for her populace in terms of sufficient food availability. However, most land have undergone land reclamation due to excessive buildings.

Therefore, the approaches "sustainability" term remains diverse, particularly in agriculture. The challenges of diversity issues reflect faced by unique communities can be seen in different dimensions like politics, social and environmental, economic, knowledge and technology, just to mention a few that go along with tidal lowlands that are located along the northern Terengganu are of Besut which include several sub-districts such as Gong Nerin, Gong Tanah Mera and Kubang Depu lowlands as agricultural resource which is anticipated to sustain crop production requirements to be sustained in order to fulfil food needs for the next generation. Tidal lowlands can be retained through proper utilization of agricultural inputs, sufficient maintenance of infrastructures, and effective control on farmland from conversion Hoang and Alauddin (2012). Although, there is a deficiency of applicable measures in deciding crop production sustainability. With several signs of sustainability that are found in the SDGs, and cannot be used to quantify the sustainability of crop production since the indicators are inadequate in terms of calculations and not in agreement with some exact site for the production crop. Hence the study to checkmate and assess the tidal lowland is necessary and "what is the way out for researcher to implore for a sustainable yield of crop production in tidal lowlands

Whilst domestic production has been increasing judiciously, consumption has been increasing at a more rapidly step. Stating that consumption outshines production in Malaysia, as imported rice plays a vigorous role in closing the gap. However, the dependence on imports at the back of limited domestic resources and production capacity naturally lead to concerns related to food security and the nation's ability to be self-sufficient in its rice production. Unsurprisingly, policies have thus always tended to focus on increasing total production of paddy in bulk for cheap local rice with less focus on premium, specialty rice products. However, the latter seems to hold some potential towards reviving the tidal lowland, which could help to improve the farmers' income and SDGs.

Therefore, this segment of tidal lowland crop production is given specific attention in this report of SDGs through review of relevant papers. The objective of this paper is to target a constant increase in food production, especially for rice (the staple food of the dwellers) and challenges of sustainable crop production in tidal lowlands, based on sustainable development goals achievements.

Methodology

Malaysia is located in southeast Asia. It is a collection of two regions: peninsular Malaysia in the west, lying amid Thailand and Singapore, and the states of Sabah and Sarawak, situated in the east of the island shared with Indonesian Borneo. The two regions are separated by the South China Sea. The total land area is 330 800 km^2 FAO (2009). Malaysia is a federal country, divided into 13 states and one federal territory (wilayah persekutuan), which includes the city of Kuala Lumpur (legislative capital), Labuan and Putrajaya (administrative capital).

Tidal lowland is located in a flat area near the sea which is dependent on tidal movements. Water in tidal lowlands is normally fresh water from the river which is due to the influence of tidal and low tide of the sea water, is used to irrigate the land through irrigation and drainage canals Purba and Yazid 2018. This paper was carved through assessment of relevant literature in crop production and soil science development in tidal lowlands from both theoretical and methodological perspectives. theoretical and methodological perspectives of this paper was written through assessment of relevant literature both in crop production and soil science discipline for tidal lowland crop farming development. Most of the literature reviewed include papers journals, articles and sustainable development goals (SDGs) documents, and reports.

Results and Discussion

Tidal lowland is generally located around main river that is influenced by tidal and low tides (Puslitbangtanak, 2003). Tidal lowland is located in a flat area, so that overflowing and periodic inundation become its typical characteristics (Ar-riza and Alkasuma, 2008). In addition to land typology, the type of overflow has a very important meaning in determining the suitability of the area for farming. Based on its hydro- topography tidal lowland can be classified into four categories, namely: 1. Type A is an area that can be overflowed by either high or low tide. 2. Type B is an area that can only be overflowed by high tides. 3. Type C is an area that is not flooded by tide, but the depth of groundwater level is less than 50 cm below the ground. 4. Type D is an area that is not affected by tide at all and the depth of groundwater surface is more than 50 cm below the ground. Types A and B are often referred to as direct tides, while types C and D are referred to as indirect tides (Ar-riza and Alkasuma, 2008). Tidal lowlands have the prospect to be developed into agricultural land to support crop production. Therefore, its sustainable use must be conserved for future generations.

The Department of Statistics Malaysia (DOSM) is appointed as a focal point in the coordination of the development of SDG indicators that focuses on Malaysia's social, environmental and economic development figure 1. Prior to the role as a focal point," (goal[2] under UN-SDG) of the initial assessment of the SDGs indicators to be used by the government agencies, private sectors, academicians and individuals for SDGs implementation.

Therefore, this research will focus on the 17 goals provided by the SDGs with regards to crop cultivation in the areas of tidal lowland Sustainable development is a development that meets today's needs without compromising the ability of future generations to meet their needs. There are several components in sustainable development such as economic growth, social inclusion, and environmental protection. Sustainable development can be achieved if the three components is well assimilated with each other (goal[2] under UN-SDG).

Social Environment Economic

Figure 1: Source: Department of Statistics, Malaysia

This framework was adopted by the General Assembly on 6 July 2017 and contained in the Resolution adopted by the General Assembly on Work of the Statistical Commission pertaining to the 2030 Agenda for Sustainable Development (A/RES/71/313). In addition, this assessment also compiled a list of 112 proposed proxies or supplementary indicators as suggested by agencies and outcome of the 11^{th} Malaysia Plan's mapping activities. In view of this work, this research tends to look into two goals of SDGs, which are #2 and goal #13 of the SDGs. Hitherto, economic factors have been prioritized while climatic issues are more or less ignored, even though human beings as social factors will never be separated from climatic influences (Giddings 2002). The concept of sustainable development is proposed to cope with this situation. The figures 1 above depicted the relationship between the three components of sustainable development. Based on the definitions, maintaining the sustainability of tidal lowlands means the need for food is sufficient for current as well as for future generations. This concept is important to overcome the threats to sustainable crop production in tidal lowlands such as excessive use of seed in direct seedling, the use of chemical fertilizers, herbicides, pesticides, and inefficient use of water due to improper water management.

In line with the perception of sustainable development, numerous studies of different program for measuring and shaping suitable mean to sustainability of crop production in tidal lowlands is recommended in accordance to achieving Sustainable Developement Goals (SDGs). The plan accommodates the economic and social measures to reflect the productive means of crop cultivation and the efficient use of agricultural inputs. It also includes environmental measures to reflect effective control of agricultural waste and pollutant. The following (figure 2) road map indicate the flow of the achievable SDGs

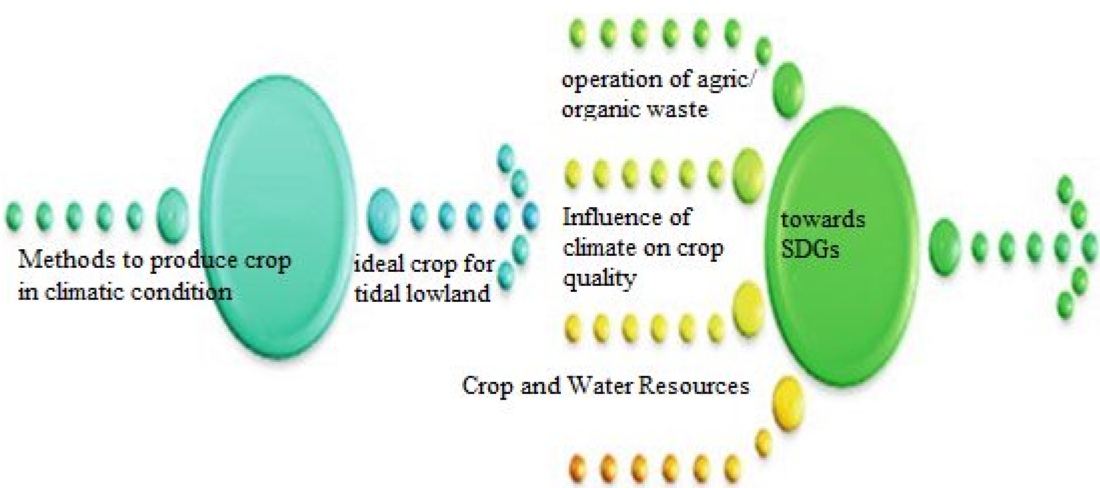

Figure 2: SDGs Road Map

Method to Produce Crop in Climatic Condition

Asia on her own has more land under cultivation than all of the industrialized nations taken together (FAO 2002). Climate change is likely to impact agriculture and food security across the globe. A large fraction of the world's food is grown as rainfed annual crops in the tropics, where climate variability plays an important role in determining productivity (Slingo et al 2005).

Although crops grown at mid-latitudes may be less sensitive to climate variability under current climates (Slingo et al. 2005), crop production in some of these areas will become riskier under future climates as, for example, competition for water resources increases, and the frequency of extreme temperatures changes. Globally, all societies will be vulnerable to changes in food production, quality and supply under climate change along with their consequent socio-economic pressures.

To increase food production for the growing population under increasing scarce water resources, which can be achieved by improving crop water productivity (Bouman 2007; Kijne 2003). Water productivity is a concept to express the value or benefit derived from the use of water and includes essential aspects of water management such as production for arid and semi-arid regions Singh 2006. Increasing water productivity means either to produce the same yield with less water resources or to obtain higher crop yields with the same water resources (Zwart 2004).

Problem in tidal lowland farming is the presence of pyrite which causes the soil acidity to increase. Pyrite is a substance, mostly found in wetland Sustainable Development Goals (SDGs) in tidal lowland areas. It is mostly formed when the land is flooded by sea water that enters during the dry season. In inundated conditions, pyrite is not harmful to plants. However, when exposed to air (oxidized), the pyrite forms into iron and sulfuric acid which can poison plants (Widjaja 1997). To solve the problem, water management to maintain ground water level become the most effective solution (Imanudin 2012; Hutahaean 2015). The other factors include soil characteristics such as soil water storage Eitzinger 2001, long-term condition in soil fertility (Sirotenko 1997), climate variables and enhanced atmospheric CO_2 levels (Amthor 2001) and the uncertainty of the crop growth model, which is connected with biophysical interactions. All of these factors will affect the estimation of climate change impacts on crop productivity. As long as the researchers reduce the effects of uncertain aspects, it is possible to obtain more accurate predictions about climate change impacts on crop productivity.

As elucidated in SDGs, sustainable crop production structure requires good agronomic practice to increase production and maintain the ecosystem and take urgent action to combat climate change and its impacts in 2030. As expounded above, it is essential to research on the topic of method to produce crop in climatic condition to examine what productive ways that can maintain the sustainability of crop production in tidal lowlands. This paper is likely to serve as measures for sustainable cultivation and recommendations for good agriculture practice in tidal lowland crop production and maintenance of tidal ecosystem.

Ideal Crops for Tidal Lowland

In anticipation lately, study specified that the optimistic influences of CO_2 fortification would most likely recompense for the negative influences of rising mean temperatures (which truncate the growing period of peak annual yields, and so reduce produces of existing varieties). These inferences were largely based on studies of crops grown in field chambers or in controlled environments that revealed that the yield of CO_3 crops (such as rice, soybean and wheat) increased by 24–43% with doubled CO_2 (Slingo et al. 2005). Conversely, a new investigation based on a small number of studies of crops grown in near-field conditions suggest that the benefits of CO_2 enrichment may be less than this, in the range of 8–15%(Long et al. 2005). Realizing the benefits of CO_2 fertilization also depends on water and nitrogen availability and hence on the optimal management of the crop (Erda et al. 2005).

Customary farming methods depend on the use of outmoded seed varieties and crop growing methods in small and dispersed areas. The exercise has led to uneven and potentially uneconomical cultivation of paddy. As a result, yield and income for rural farmers tend to be poorer. To increase income, farmers are often encouraged to use modern farming techniques to increase their productivity. These techniques include the use of high-yielding seeds, machines, chemical fertilisers or herbicides and designated infrastructures. intensive tillage, monoculture, irrigation, application of inorganic fertilizer, chemical pest control, genetic manipulation of domesticated plants forms the backbone of modern SDG for agriculture.

The situation was defined as a “system of production that makes agriculture economically viable, ecologically sound, socially fair and humane (equitable), culturally applicable and grounded on all-inclusive (schemes and integrative) science”. Nurmalina (2008). Hence, the paddy and rice supply chain in area of study Figure 3 should be developed and improved. Smallholders can benefit from having a local milling facility or coordinating among themselves to bulk-buying of inputs and selling grains to downstream buyers. Awkwardly, often the development of these linkages and supply chain demands human capital, which are expensive for most smallholders, and is a risky business venture for private companies.

Figure 3: study area

Operation of Agriculture and Organic Waste

Product or end product from industrial activity which is due and is unusable turns out to be industrial waste. It includes all the products that are useless and may harm the environment on an individual or global level. For example, burning of woods or coal for cooking purposes at restaurants may yield CO (carbon monoxide). A handful of the built-up wastes are paper products, sandpaper, metals, paints, chemical solvents, radioactive wastes, and other industrial by-products.

Table 1: Permissible limits of various elements in industrial pollutants for soils of crop fields; typical concentrations of these elements in soil and crops under normal conditions

Element	Safe limit (μg/g)	Soil concentration (ppmd.wt)	Concentration in crops (ppm d.wt)
Cu 4–15	140	2–100	2.5 mg/kg (WHO/FAO)
Fe	—	7000–55,000	400–500 mg/kg (WHO/FAO)
Zn	300	10–300	15–200 20–100 mg/kg (WHO/FAO)
Mn	—	100–4000	15–100
Ni	75	10–00	1.0 0.02–50 (WHO/FAO)
Co	—	1–40	0.05–0.5
Pb	300	2–200	0.1–10 0.05–30 mg/kg (WHO/FAO)
Cd	3	0.01–0.7	0.2–0.8 <2.4 mg/kg (WHO/FAO)
Cr	150	5–3000	0.2–1.0

Source: European Union 2002; Allaway 1968

Influence of Climate on Crop Quality

Climatic conditions: For agricultural commodities such as coffee, fruit and wheat the climate can exert a great influence on supply. Favourable weather will produce a bumper harvest and will increase supply. Unfavourable weather conditions such as a drought will lead to a poor harvest and decrease supply. These unpredictable changes in climate can have a dramatic effect on market prices for many agricultural goods. Important climate thresholds for food crops include occurrences of high temperatures that coincide with critical levels of the crop cycle. These high-temperature occurrences can lead to intense reductions in yield, in some cases in excess of 50%; for example, temperatures greater than 30^0C lasting for more than 8hrs lead to reduced grain-set in wheat (Porter & Semenov 2005).

Investigational studies have led research in this field and these are beginning to be understood in terms of simple physiology. Quantitative methods to simulate and predict the impacts of high temperature episodes are being developed and combined with the probabilistic simulation methods in order to enable the assessment of the impacts of climate extremes on crop yields (Challinor et al. 2005). Climate change scenarios suggest that critical temperature thresholds for food crops will be exceeded with increasing frequency in the future. For some crops, these critical temperatures, particularly at flowering, are reasonably well known (e.g. temperatures greater than 35 8C for more than 1 h leads to pollen sterility in rice), but for others they are not well characterized. In general, the reproductive limits for most crops are narrow, with temperatures in the mid-30 8C representing the threshold for successful grain set (Porter & Semenov 2005).

Crop and Water Resources

It is, generally, accepted that the availability of water for agriculture will be a key issue for crop production in the coming decades. There is a focus worldwide on how to improve the efficiency of water use for crop production. However, water availability for crops depends on processes across a range of spatial scales, and its assessment requires the integration of information from crop, climate and hydrological models. For example, for irrigated crop production, large-scale changes in rainfall will influence the water that is available from stream-flow or groundwater sources. Higher CO_2 levels improve the water usage efficiency of most crops. Plant transpiration is reduced under higher CO_2 and the crop loses less water. These changes in transpiration can alter the hydrological balance over land and affect the local climate, particularly where there may be large-scale changes in land use associated with extensification of agriculture (Betts 2005). Reduced transpiration over a sufficiently large region could lead to reduced precipitation there as well. This highlights the inherent links between crops, climate and the water cycle, and suggests the need for fully integrated crop/climate displaying approaches to take careful account of hydrology (Betts 2005; Huntingford et al. 2005).

Climate models still have substantial regional biases, particularly in their representation of the spatial and temporal scales of rainfall. The distribution of rainfall through the growing seasonal is critical for many crops, particularly in the semi-arid Tropics. These variations in rainfall, generally associated with dominant weather patterns, are currently poorly simulated in climate prediction models.

Towards SDGs

It is important to consider the complete food chain from production to distribution, access and utilization (Gregory et al. 2005). This requires an appreciation of the intimate relationship between climate, socioeconomic and environmental factors, and an understanding of major economic sectors and the embedding of agricultural systems within national economies. There are several definitions of sustainable agriculture, but each tends to be applicable to site-specific environments. Most definitions of ecological sustainability centre on maintaining agricultural productivity and farmers' profits while minimizing environmental impacts (Rahman, et al., 1999).

Neher, (1992) proposed ten general features associated with the concept of sustainable agriculture. These are: selection of crop varieties and/or livestock which are suitable to farm's soil and climate, also they are resistance to pests and pathogens; livestock housed and grazed at low densities; on-farm resources; diversity of crop species either by rotations, intercropping, or relay cropping practices; applying deep-rooted crops in crop rotations; using cover crops and mulching; soil management; controlled inorganic pesticides application; using limited artificial pesticides; and restrict biocides application to minimum level.

Tisdell (1999a) considers three conditions as being important for ecologically sustainable agriculture as: "sustainable use of the biophysical environment; economic viability and, social acceptability". These conditions are similar to those proposed by (Neher, 1992) in which the three basic components of ecologically sustainable agriculture are identified - "plant and/or animal productivity, environmental quality and, socio-economic viability". Systems that meet these conditions often sustain good yields, have lower costs of inputs, demonstrate increased farm profits and reduce ecological problems (Edwards, 1990). Such models are associated with the possibility of practicing low external input agriculture (LEIA), which reduces the application of inorganic fertilizers, chemical pesticides, and so on (Tisdell, 1999a).

To date, research carried out in tidal ecosystems in Indonesia focuses on reclaimed land in such areas, and concentrates on increasing production output by intensive cropping or by pursuing the possibility of cultivation expansion (Balai Penelitian Tanaman Pangan, 1995a; Manwan, et al.; 1992, Supriyo, et al., 1991). However, the strategy of intensive crop cultivation and/or agricultural land expansion without considering the environmental aspects may jeopardize ecologically sustainable development in the long-term, particularly sustainable agricultural production. Sequentially, this will lead to impairment, not enhance SDGs durable, forecasts for self-sufficiency in food production. Indonesia food security is thus critically dependent on sustainable farming practice.

By contrasting and comparing the two systems of rural dwellers and trans-migrant farming practices considered in this study, it is likely to run a rigorous basis on which to initiate a realistic development in the tidal swamp farming systems that is environmentally sustainable in the long run. Study outcomes are likely to be important for environmentally sustainable agricultural strategy development purposes. The study results, while based in the tidal swamplands of Terengganu, will also be relevant to other areas across the country, and somewhere else in the world with comparable environmental conditions.

Conclusion

Sequel to attainment of sustainable crop cultivation in tidal lowlands based to Goals #2 and #13, the program of sustainable crop creation in tidal lowland should consist of: Investigation on procedures of productive means of crop cultivation in tidal lowlands to produce with the indicators of SDGs that contribute to the realization of goal #2 of The SDGs to ensure sustainable agriculture practices. Pursuing an actual influence of climate on crop quality with agricultural waste and pollution in crop production in tidal lowlands to achieve goal #13 of The SDGs to safeguard liable production system and reduce chemical use in crop production.

Estimate the efficient use of agricultural inputs in crop production in tidal lowlands to achieve goal #13 of the SDGs to ensure sustainable management and resource operation and competence.

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