SOIL CONSERVATION KNOWLEDGE IN OIL PALM PLANTATION AMONG FUTURE PLANTATION MANAGERS IN INTERNATIONAL COLLEGE OF ADVANCED TECHNOLOGY SARAWAK (ICATS)

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Soil Conservation Knowledge in Oil Palm Plantation among future plantation managers in International College of Advanced Technology Sarawak (ICATS)

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<td>International College of Advance Technology Sarawak</td>
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<td>DPM</td>
<td>Diploma in Plantation Management</td>
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<td>NKEA</td>
<td>National Key Economic Areas</td>
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<td>ETP</td>
<td>Economic Transformation Programme</td>
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<td>SCORE</td>
<td>Sarawak Corridor of Renewable Energy</td>
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<td>Oil Palm</td>
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<td>NGO</td>
<td>Non-Government Organisation</td>
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<td>Farmyard Manures</td>
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CHAPTER 1

1.1 Introduction

Palm oil and related products and education service among the 12 National Key Economic Areas (NKEAs) under the 10 Malaysia Plan (MP) have been described as having great potential to generate high income for the nation in the Economic Transformation Programme (ETP). NKEAs contribute a quantifiable amount of economic growth to the Malaysian economy directly and materially. According to economist ETP has helped to improve and driver of the country's economy. Key to the economic transformation is a focus on the NKEAs and improving the country's competitiveness. Palm oil and education service in NKEAs will receive prioritised government support including funding, top talent and Prime Minister’s attention. A combination of both palm oil and education service in NKEAs will contribute skilled human capital in the oil palm sector with capable to adopt an integrated and holistic approach in addressing environmental and resource issues to attain sustainable development.

Sarawak Corridor of Renewable Energy (SCORE) by 2030 also mentioned that 1.6 million skilled human capitals to meet the needs of various industries and one of the major industry under SCORE is oil palm (OP) sector. The development of SCORE will give the benefits of impact in the whole State and give citizens in the rural areas the opportunity to participate in the State’s primary goal to become a high income state on a par with the wealthiest states in Peninsular Malaysia by 2020. As employment increases in the oil palm sector, the social economic inequality between rural and urban areas will be reduced and
poverty will be eradicated. Quality of life will be improved in long term, higher income jobs will be created and the economy will move up.

Current trends in the OP industry is much pressure on major stakeholder in practicing sustainable agricultural practice. During the past forty three years, oil palm development policies have been remarkably successful in emphasizing external inputs as the means to increase food production. External input has led to growth in global consumption of pesticides, inorganic fertilizer, animal feed-stuffs, and tractors. To encounter negative campaign relative to environmental issues of palm oil and to promote the growth and use of sustainable palm oil, the Roundtable of Sustainable Palm Oil (RSPO). One major part of RSPO guideline for sustainable palm oil is the soil conservation practice consist in of RSPO guidelines (RSPO, 2007). RSPO was firstly created by some policy decision makers of palm oil in the world. The committee included all agents who had contributed in the processing of palm oil from states, farmers, producers, industries, and the secondary sectors of distributors, consumers, Non-Government Organizations (NGOs), environmentalist, exporters and importers of palm oil in the world market. The purpose of the RSPO is to increase growth and usage of palm oil through cooperation in the production cycle of palm oil, and to develop the dialogue process among the agents. There had been agreement on a clear and concrete definition about palm oil production for sustainable development.

To ensure the successful implementation of sustainable OP cultivation practice in the plantation sector, skilled and knowledgeable human capital is necessary. The needs of the future human capital especially the policy makers and land managers in the oil palm industry is to possess sufficient knowledge of soil conservation practices in oil palm plantation is
essential so that the management in oil palm plantation with regard to utilizing the land resources can be managed in a sustainable manner.

Due this factor, Malaysia in need of skilled workforce especially in OP sector. Thus, for human capital building, ICATS has implemented a Diploma Program in Plantation Management. The goal of the program is to produce qualified and certified skilled workforce from skill enhancement in the plantation industry. Syllabus DPM in ICATS includes the knowledge of soil conservation especially in oil palm plantation. The soil conservation study is the first step to address such issues above. In addition, it also a preparatory step before they go into industry training at the end of the semester. Diploma in Plantation Management was offered in ICATS since the year 2009. Since the start of this programme, a total number of students are 262. Students had graduated and recently, 215 students had enrolled in this programme. Statistics by ICATS Department of Students Affairs, found that almost 90% of DPM students were attached with oil palm plantation for their industrial training. After graduation, statistic shown that 70% of the alumni’s are currently attached in the oil palm plantation sector as Assistant Managers, Senior Supervisors, Supervisors or in some cases as a ‘Mandur’. DPM is a three year programme (6 semesters) which consisted of 30 courses. 20 out of 30 courses are major courses related to plantation management (i.e. Principles of Crop Management, Plant Science, Introduction to Plantation Industry, etc.). Syllabus curriculum offers in DPM with regards in soil conservation knowledge such as soil science and land management. DPM third semester students will study soil science subject while the land management subject will be studied in the fourth semester. Soil science syllabuses consist of general learning units on soil conservation at any agricultural land and Land Management syllabuses consist of learning units on soil conservation in oil palm plantation at various agro ecosystems.
1.2 Problem statement

Several studies (Chan et al., 1980; Ndiaye and Sofranco, 1994) had found soil conservation is an important factor for crop productivity and environment sustainability. For instance Chan et al. (1980) mentioned crop production increased based on soil quality and it had indicated that soil conservation is important to sustain the environment. Ndiaye and Sofranko, (1994) also found that the knowledge of soil conservation is indeed compulsory for plantation practitioners in oil palm plantation. Yet, there had been no study that examined the level of knowledge among students and graduates of ICATS with regard to soil conservation, particularly in the oil palm plantation.

1.3 Study Objective

(This study is conducted to assess the level of knowledge in soil conservation among the plantation managers in particular, the present DPM students and graduates of ICATS. The findings of the study could be used by ICATS to redesign the program curriculum and syllabus by means to prepare the DPM graduates for industrial training and subsequently to prepare them for work in the OP sector.)
CHAPTER 2

LITERATURE REVIEW

2.1 Human Capital and Education NKEA (National Key Economic Areas)

The oil palm industry was facing several challenges such as lack of manpower. Thus, developing human capital was important for the industry as it would play a role in the development of the Sarawak Corridor of Renewable Energy (SCORE). Investments in human capital are critical as an engine for growth of a nation (Azariadis and Drazen, 1990). Public education is provided by governments, although private provision of education exists, in order to foster growth (Glomm and Ravikumar, 1992). Therefore, the Education NKEA in Malaysia Tenth plan focuses on the role of private institutions in leading innovation and driving growth in the industry. The private institution attempted to increase the supply of skilled labour to OP sector specifically and in Sarawak, ICATS is among the pioneer private institution that offer DPM.

2.2 DPM Syllabus on Soil Conservation

2.2.1 Rationale of Soil Science Subject to the Inclusion in the DPM Programme

This subject aims to provide information for the student to more understanding and appreciate the ecological importance of soil, have a basic understanding of how soil and form
the pattern in which they occur in landscapes. Know the principles type and identify the soil, ecology, type of ecosystem and abiotic factors in the natural environment. The course will cover soil science and management emphasizing the physical, chemical, biological properties of soils in relation to the growth of the native agricultural plant as well as nature use and scope of soil in Malaysia.

2.2.2 Rationale of Land Management Subject to the Inclusion in the DPM Programme

This subject aims to provide thorough comprehension on the sustainable land management and conservation that is relevant to crop production in the agriculture sector. The students will also be exposed to management techniques of important specific land management problems in the plantation industry, such as managing most common problem lands i.e Peat Land, Acid Sulphate Land, and BRIS Land for the agricultural plantation purpose.

2.3 Sustainable Agriculture Education in Oil Palm (OP) Sector

Education as regards of oil palm plantation is widely considered to be the most important form of human capital in the OP sector (Becker, 1993). A major part of formal education or general intellectual achievement is obtained in colleges or universities which offered Diploma in Plantation Management Programme. Investment of students’ and lecturers’ time and other inputs are used in the learning process, of an individual beyond the permanent literary level, which is generally 3 – 4 years in colleges or universities, has lifetime impacts on almost all of his or her activities.
The development of knowledge about soil conservation in their education seems to be a major factor causing the long term rise in labour productivity, especially in soil conservation management. The knowledge of soil conservation grows the opportunities to produce new sustainable technologies in OP sector that become embodied when new capital goods occur (Huffman and Evenson 1993). According to Orazen et al., (1997) and Griliches 1969 the demand for skilled with highly educated labour grows relative to the demand for less skilled labourers that as in regards of sustainable agriculture knowledge. This is supported by Holt and Schoorl (1985) agricultural extension via education services plays an important role in the diffusion of innovations also important for training new participants, for maintaining high quality soil erosion control measures, and for implementing a broad range of natural resource management services in addition to soil and water conservation practices. This gives emphasis to the importance of developing human capital, via education and extension services, for increasing adoption and use of soil conservation technologies, and for developing policies that improve extension services for diffusing information (Anley et al., 2007).

2.4 Malaysia Oil Palm (OP) Sector

OP is one of the important commodities in the Malaysian economy. Malaysia OP is highly demanded particularly in the overseas market. The majority of OP production was exported rather than consumed in the domestic market. The two main products that were mostly exported are crude palm oil (CPO) and palm kernel oil (PKO). CPO is mainly used in
food industry, detergent and oleo-chemical plant. Meanwhile, PKO is mainly used in chemical and animal feed industry.

In the year 2011, land coverage for OP plantation in Malaysia reached 5.00 million hectares, an increase of 3.0% against 4.85 million hectares recorded the previous year, especially Sarawak which recorded an increase of 11.0% or 102,169 hectares OP planted area. Sabah is still the largest oil palm planted state with 1.43 million hectares or 28.6% of total oil palm planted area (MPOB, 2011). Two main reasons for large OP expansion in Malaysia are economic growth of India and China, and demand for bio-fuel energy alternative. The Malaysian government putted efforts to support OP expansion like the Malaysian Palm Oil Board (MPOB), Malaysian Palm Oil Council (MPOC), and Malaysian Palm Oil Association (MPOA). Consequently, the area of OP plantation in Malaysia increased significantly over time from 1975 to 2011. Which is in 1985, 1.5 million hectares were planted with palm tree, and 2007 it had increased to 4.3 million hectares. As of 2011, the total planted area was 4.917 million hectares (MPOB, 2011).

2.5 Environmental Impacts of Malaysia Oil Palm (OP) Sector

The OP expansion in Malaysia brings economic benefits as well as environmental issues. In recent years, palm oil expansion is criticized for environmental impacts such as causing deforestation and greenhouse emission (Koh and Wilcove 2008). The critics come firstly from the European Union that accused palm oil export from Malaysia, and these are supported by many International NGOs and domestic NGOs as well. This seems that there is a trade-off between palm oil expansion and environmental impacts caused by expansion. The
environmental impacts of any economic activity cannot be avoided fully but it can be minimized by some policies to support environmental protection. The main challenge is to strengthen the farmers to plant OP on the appropriate land and process that can cause the less of the environmental impact of OP. According to Lord and Clay (2007) classified the environmental impact of OP plantation into impacts on air quality, soil, habitat conversion (biodiversity) and water.

OP plantation causes environmental impact both on soil quality and quantity. Soil erosion is the most popular impact. Most soil erosion risk comes from new plantation and replanting process of oil palm. The channel of OP plantation has an impact on the soil erosion through land clearing and road construction as stated by Sidle et al (2006). According to Frey (2002) stated that the negative impacts of deforestation are causing the watershed degradation and drying land that increase risk of fire, erosion and soil degradation, biodiversity loss, resource limitation, and greenhouse gas emission. In the past, Malaysia with annual deforestation rates in excess of 250 000 ha per year (Wood 1990).

2.6 RSPO Principles and Criteria for Sustainable Palm Oil Production

RSPO is a guideline to practice environment conservation in oil palm sector and soil conservation is one of the criteria used to overcome the issue of environment impact due to oil palm plantation development. The guideline mentioned in Principle 4, criteria 4.2 (Practices maintain soil fertility at, or where possible improve soil fertility to, a level that ensures optimal and sustained yield) and criteria 4.3 (Practices minimize and control erosion and degradation of soils) (RSPO, 2007).
2.6.1 Knowledge to Maintain and Improved Soil Fertility to a Level That Ensures Optimal and Sustained Yield.

a. Soil Fertility

According Plaster, 1992, soil fertility is defined as the growth of plants depends on nutrients that supply by soils which are known as a plant nutrition storehouse. Plant nutrients can be determined by plant growth or reproduction. If they stop completing growth or reproduction, it defines the soil lack of the element of the plant and can be corrected only by supplying those elements (Plaster, 1992). The nutrients they need for growth divided into two categories, there are macronutrients and micronutrients. Macronutrients are important nutrients because plants use these elements in large amounts there are phosphorus, potassium, calcium, magnesium and sulphur. Meanwhile, the micronutrient use by plant growth in small amount such as boron, copper, chlorine, iron, manganese, molybdenum and zinc (Plaster, 1992). The soil fertility and plant nutrient can be maintained by use leguminous cover crops, oil palm residue and crop rotation to provide nutrient cycling, nutrient uptake, organic matter balance, increase beneficial microorganism population and humus decomposition (Pieri C., 1992; Haron K. & Zakarian Z.Z., 2000).

b. Maintaining Organic Matter in Soil

Organic matter in soil can be maintained by reuse of oil palm residue and indirectly it can reduce the environmental impact paving the way towards a zero-waste policy. The nutrients by oil palm residue such as oil palm fronds and empty fruit bunch (EFB) enhance
organic matter about 10% - 20%. The nutrient of organic matter is mostly found in the pruned
fronds (Singh et al., 1999; Chan et al., 1980; Haron & Zakaria, 2000). The organic manure
from oil palm residue provides organic matter balance and large amounts of several elements
in the soil especially improvement of soil organic carbon content (Chang et al., 1980). According
to Singh et al., 1999, palm mulch with EFB showed earlier maturity at about 20
months than 30 months without much of EFB.

c. Encourage Population of Beneficial Microorganism Practices (BMP)

Establishment of LCC after land clearing help to improve increasing beneficial
microorganism, soil structure, maintaining the biodiversity of soil fauna, plant root
development, nutrient cycle and pest and disease control (Uexkull & Fairhurst, 1999; Haron
& Zakaria, 2000). Apply organic fertilizers with poultry, pig and cattle manure all add
organic matter to the soil. Again the nutrients in these fertilizers have to be taken into account
under the nitrates regulations. Crop rotation including grass in the cycle may restore organic
matter levels depending on the particular circumstances. Min-till, and no-till systems on their
own will not significantly increase organic matter levels in soil but will reduce the rate of
decline. When combined with other actions such as straw incorporation and green manure.
They will help to maintain or increase the organic matter level.

d. Oil Palm Recycle biomass

Most of recycled biomass they use in oil palm plantation is pruned fronds and EFB.
On oil palm plantation, they are used as mulching. The benefit of mulching are improving
soil water content, reduce erosion and decrease soil temperature especially when sunny day (Plaster, 1992). Mulching is a practice where the pruned frond is placed in inter-rows between oil palm meanwhile EFB there place around young oil palm and for mature oil palm there place in inter-rows between mature oil palm as though the placement of the pruned frond (Basiron, 2008). Other oil palm residues such as felling oil palm trunk during replanting, and by product from the oil palm mill like fibre, shell and POME is also used as mulch and organic manure (Chan et al., 1980; Plaster, 1992).

2.6.2 The Knowledge to Minimise Control Erosion and Degradation of Soils

a. Soil Erosion and Degradation

Soil erosion as an agent of land depreciation and destruction constitutes the biggest problem confronting the physical side of land utilization. Bennet (1992), indicated that productivity and usefulness declining on agricultural lands at a vastly greater rate than most of us have suspected (Bennet. 1929). According to El-Swaify et al., 1982, soil erosion is perhaps the most serious mechanism of land degradation in the tropics generally and the humid tropics in particular. Two factors responsible for the soil erosion there is normal or geologic erosion and accelerated erosion related to human intervention in the environment. Normal or geologic erosion refers to slow removal of surface soil process by water and wind (Koley, 1993). The effects of human intervention are determined by overgrazing of rangeland, over-cultivation of cropland, waterlogging and salinization of irrigated land and deforestation (Shanan, 1987; Limpinuntana & Arunin, 1986). A raindrop causes the soil surface shatters soil aggregates into the air. On a slope, water as a transport brings soil grains
from top to flow downhill. Water on a slope joins other flowing water, increasing speed, volume and soil-carrying capacity.

These impacts leads to five types of erosion there are splash erosion, sheet erosion, rill erosion, ephemeral gullies and gully erosion (Plaster, 1992). The wind is responsible for the removal of soil particles by the following three kinds of erosion there are saltation, suspension and surface creep (Gardiner & Miller, 2008). Increasing livestock numbers, exceeding the potential carrying capacity of rangelands, have been seen as a common cause of overgrazing. Overgrazing causes destruction of vegetative cover by eating and trampling, disturbance of root systems by scuffling, and compaction of the surface reducing infiltration and accelerating runoff and soil erosion (Thomas & Middleton, 1994).

b. Land Cover Crops (LCC) Management

Cover crops are frequently planted in oil palm plantation (Broughton, 1976), as well as with coconut plantation (Aldaba, 1995). LCC provides of nitrogen, N for soil. The N balance of cropping system can be improved using legumes as a cover crop because they fix atmospheric N\textsubscript{2}. In terms of biological magnitude, N fixation of legumes is highly variable and depends on leguminous species (Giller & Wilson, 1991). Cover crop that is often used in oil palm plantation is \textit{Pueraria phaseoloides}, \textit{Desmodium ovalifolium}, \textit{Calopogonium mucunoides} and \textit{Centrosema pubescens}. The most popular and widely grown cover crop is \textit{Pueraria phaseoloides}. \textit{Pueraria phaseoloides} grows well under direct sunlight and disappears with increased shade. The main shade tolerant cover crop is \textit{Desmodium ovalifolium} which is the most common cover in mature oil palm plantations.
c. Sustainable Practice to Reduce or Control Soil Erosion at Slope Area

The most important to consider planning slope area into oil palm plantation from soil erosion are established bunds, platforms and terraces and at the same time to provide adequate access for field workers and harvesters and to reduce soil erosion and surface runoff. Other than that, planting of LCC and reused of felled trunk, pruned fronds and EFB also can reduce or control soil erosion especially at slope area. Conservation bunds should be formed along the contour at 20 m intervals and silt traps (about 500 m ha\(^{-1}\)) should be installed on gently sloping land (<5° or <9°) (Caliman and de Kochko, 1987; Gillbanks, 2003). According to Caliman and de Kochko, 1987, land slopes with 5-10° (9-18%) individual palm platforms are required, slope exceeds 10° (18%) measure to be taken is the establishment of terraces is must and full terracing where the slope exceeds 5° (9%). RSPO, (2011) had already set an upper limit of 20° (36%) slopes for oil palm development. Therefore, oil palm planters should make careful assessment of slopes prior to the development of oil palm, so that areas with slopes greater than 20° (36%) are allowed to regenerate into full forest cover.

LCC was grown to provide nutrients and at the same time prevent land degradation by wind and water erosion especially in slope area. The fast growing, perennial, creeping legumes are expected to quickly provide a dense vegetative growth covering the soil resulting in improvement to protect the soil from erosion as most of the land is undulating and receives high annual rainfall (around 4000 mm). Without this protection, direct sunlight and heavy precipitation break down the soil aggregates which seal the surface and reduce the infiltration of rainwater and causes soil erosion in sloping lands.
d. Water Table Control in Peat Soil

The establishment of a functional water management system which involving drainage also maintenance of a water table close to the surface to prevent excessive drying is a prerequisite step for successful oil palm establishment on peat (Othman et al., 2011). The drainage development in peat soil must suitable for dry and drought season. During the dry season, water must be conserved to prevent irreversible drying of peat drought stress on newly planted oil palms. Thus, a gate with removable wooden blocks and removable sand bags is required at each palm block to maintain the water level between 30 to 40 cm in the field drain and 40 – 50 cm in the collection drain from the peat surface (Othman et al., 2011). During rains, the drainage system must be able to accommodate a greater volume of flow, as oil palm roots will be affected by reducing aeration in stagnant water (Othman et al., 2011; Couwenberg, 2011).