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CARBON TRADING AND THE POTENTIAL OF INDONESIA'S OIL PALM PLANTATIONS

By

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RESUME

Carbon trading is one of the vehicles to expand the participation of the businessmen and public to take part in efforts to reduce global GHG emissions. Carbon trading essentially adopts the Polluter's Pay Principles (PPP). Oil palm plantations have the potential to participate in carbon trading. Three schemes for reducing global GHG emissions from oil palm plantations are carbon stock conservation, carbon stock enhancement, and emission reduction in the palm oil production process.

INTRODUCTION

The carbon exchange in Indonesia has been opened and inaugurated by the Indonesian President Joko Widodo on 26 September 2023. The opening of the carbon exchange is a follow-up to the Presidential Regulation No. 98 of 2021 (Perpres 98/2021) on the Implementation of Carbon Economic Value for Achieving Nationally Determined Contribution Targets and Controlling Greenhouse Gas Emissions in National Development.

This Presidential Regulation was subsequently followed up with the Regulation of the Minister of Environment and Forestry of the Republic of Indonesia No. 21 of 2022 (Permen LHK 21/2022) on the Guidelines for the Implementation of Carbon Pricing. Meanwhile, carbon trading through the carbon exchange is regulated in the Regulation of the Financial Services Authority No. 14 of 2023 (POJK 14/2023) on Carbon trading through the Carbon Exchange and Financial Services Authority Circular Letter No. 12/SEOJK.04/2023 (SE-OJK 12/2023) on the Procedures for Organizing Carbon Trading through the Carbon Exchange.

Carbon trading can be done directly or indirectly (via carbon exchange). The opening of the carbon exchange marks a new chapter and is part of Indonesia's commitment to facilitate the participation of the businessmen together with the international community in making greater contribution to reducing carbon emissions in the earth's atmosphere.

In Permen LHK 21/2022, it essentially states that carbon trading can apply to every sector/subsector and business actor, including oil palm plantations. This principle aligns with the fact that every human activity generates carbon emissions or their carbon equivalents, thus reducing emissions requires collective movement.

This journal article will discuss the history and basic principles of current carbon trading. It will then explore the potential for oil palm plantations to participate in carbon trading.

CARBON TRADE PRINCIPLES

The entire international community resides in one "big house" called the planet Earth ecosystem. The atmosphere of planet Earth is filled with waste from human activities, namely greenhouse gases (GHGs) consisting of CO_2, CH_4, NxO, and others, where the concentration of these gases has exceeded their natural levels. The Intergovernmental Panel on Climate Change/IPCC (1991) revealed that the concentration of CO_2 in the Earth's atmosphere had increased from 280 ppmv (parts per million by volume) in the 1800s to 353 ppmv in 1990. The concentration of CO_2 in the Earth's atmosphere reached 379 ppmv in 2005, then experienced an increase to 396 ppmv in 2013 and 399 ppmv in 2015, and subsequently continued to rise to 407 ppmv in 2018 (IEA, 2013, 2016, 2019). The United States Aeronautics and Space Administration (NASA) reported that the concentration level of carbon dioxide (CO_2) in the Earth's atmosphere had risen to 417.6 ppmv in May 2022.

The increase in GHG concentrations is believed to result in more solar heat being trapped in the Earth's atmosphere, leading to global warming and global climate change (PASPI, 2023). As one "big house", the impacts of global warming and global climate change are felt by the entire global community without exception and are considered to have threatened life in the planet Earth ecosystem. The solution lies in the need for a collective movement with the global community to reduce global GHG emissions and reabsorb GHG emissions that have already been released into the Earth's atmosphere.

The form of commitment of the global community is embodied in the United Nations Framework Convention on Climate Change (UNFCCC) which was established on 21 March 1994. The UNFCCC consists of 197 member countries (including Indonesia) establishing international conventions or agreements aimed at maintaining or reducing the concentration of GHGs in the Earth's atmosphere back to their normal levels naturally. UNFCC members (parties) hold Conference of Parties (COP) periodically. The first COP was held in 1995 in Berlin, Germany, and subsequently the third COP took place in 1997 in Kyoto which resulted in the Kyoto Protocol. The 15th COP was held in 2015 in Paris which later resulted in the Paris Agreement. The 27th COP was held in 2022 in Glasgow, Scotland.

Efforts to reduce GHG emissions under the UNFCCC are based on the Polluter's Pay Principles/PPP theory (OECD, 1992; Munir, 2013). According to the PPP theory, whoever produces pollution (GHG emissions) must pay for their emissions and whoever does not produce emissions, absorbs emissions, or reduces GHG emissions can receive incentives.

Developed countries which generally have relatively high emission levels are grouped in Annex 1, where these countries are obliged to reduce emissions. Meanwhile, developing countries which generally produce lower emissions (non-Annex 1) are not required to do so but can voluntarily reduce their emissions.

Indonesia has also voluntarily taken the initiative to develop an emissions reduction plan known as Nationally Determined Contribution (NDC) since 2016. Through this NDC, the Indonesian Government is committed to reduce carbon emissions by 26 percent (unconditional) and by 41 percent (conditional) in 2030 (Government of the Republic of Indonesia, 2016, 2021).

The implementation of the PPP theory in cooperation under the UNFCCC (especially the Kyoto Protocol and the Paris Agreement) takes three forms: **First**, cooperation between developed countries through Joint Investment (JI) to build emission reduction projects in developed countries (Annex 1). **Second**, cooperation between developed countries (Annex 1) with developing countries (non-Annex 1) through the Clean Development Mechanism (CDM) project to reduce emissions in non-Annex 1 countries. And **third**, the carbon trading mechanism (Cap & Trade).

The three mechanisms of carbon trading adhere to PPP theory. The group of countries with higher emissions (Annex 1) pays the group of countries with lower emissions (non-Annex 1) through the JI and CDM mechanisms. The carbon trading mechanism is guided by the Kyoto Protocol and Paris Agreement (Metcalf, 2009). Carbon trading is one of the mechanisms to reduce global emissions by expanding business actors participation (McAllister, 2012).

In the carbon trading mechanism, based on baseline procedures set by the government, each company is given a limit (permits/allowances) for carbon emissions that the company concerned may emit during a certain period. Then, after the company has operated for the specified period, the carbon emissions emitted are verified. If the amount of carbon emissions of the company concerned exceeds the carbon emissions permit that has been determined, then the company is obliged to offset its carbon emissions from other companies whose carbon emissions are below its permit. On the other hand, if the company's total carbon emissions do not exceed its permits, then the difference can be traded (tradable) either through direct trading (with companies whose carbon emissions exceed their permits) or trading on the government-regulated carbon exchange.

Compared with the carbon tax mechanism that has long been adopted by countries to control emissions, reducing emissions through the carbon trading mechanism does have a number of weaknesses. One of the weaknesses of carbon trading is the relatively high volatility of carbon prices (Metcalf and Weisbach, 2009). Carbon prices in the European region, for example, fluctuated from around 25 euros per ton of CO_2 in 2008 to only 0.15 euros per ton of CO_2 in 2019. Additionally, carbon trading is more complicated because it requires determining a baseline, distributing permits, monitoring carbon trading, offsetting carbon emissions between countries, and also licensing futures commodity transactions (Avi-Yonah et al., 2009).

THE POTENTIAL OF OIL PALM CARBON TRADE

The agricultural sector, including plantations, has long been recognized as having multifunctional are economic, social and environmental functions (Huylenbroeck et al., 2007). The ability of plants to photosynthesize, which absorbs carbon from the Earth's atmosphere, makes agriculture a solution to reducing emissions from the Earth's atmosphere.

In Permen LHK 21/2022, the plantation sector, including oil palm plantations, is one of the subsectors targeted in carbon trading. There are three schemes from oil palm plantations that can contribute to reducing global emissions (PASPI Monitor, 2023[a]); therefore, they have the potential to participate in carbon trading.

First, carbon stock conservation scheme (carbon sink/carbon sequestration). Oil palm is a perennial plant with a production cycle (life span) of 25-30 years. With these characteristics, oil palm plantations can be seen as a "carbon plantation" (Figure 1).

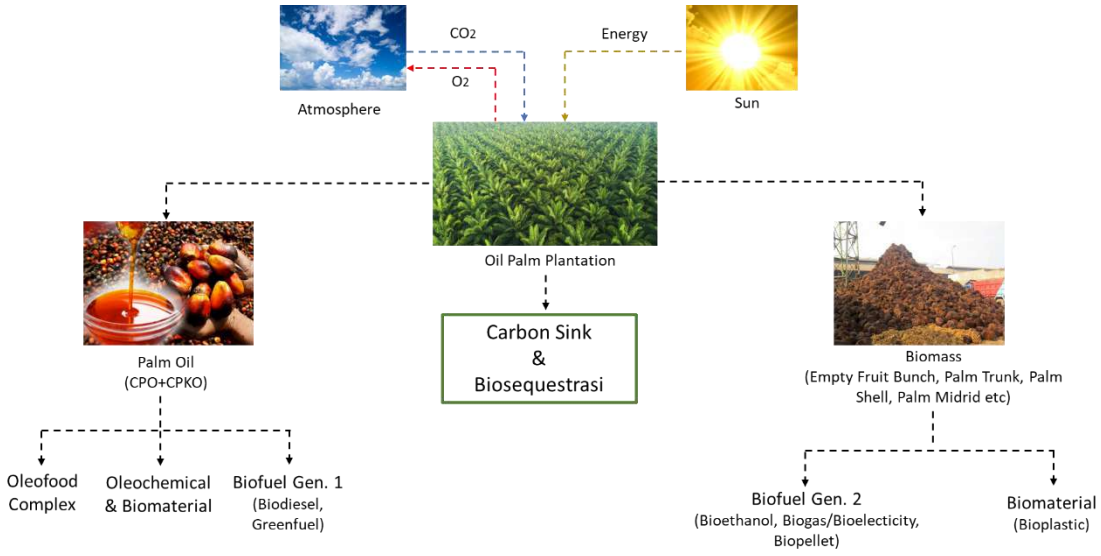

Figure 1. Absorption of CO_2 and Carbon Stock in Oil Palm Plantations

Through the process of photosynthesis, oil palm plantations absorb CO_2 from the Earth's atmosphere, approximately 161 tons of CO_2 eq per hectare, and become a net carbon sink of 64.5 tons of CO_2 eq per hectare (Table 1).

Table 1. Comparison of Carbon Absorption between Oil Palm Plantations and Tropical Forests

Indicator	Tropical Forest	Oil Palm Plantation
Gross assimilation (ton CO_2/ha/year)	163.5	161.0
Total respiration (ton CO_2/ha/year)	121.1	96.5
Net assimilation (ton CO_2/ha/year)	42.4	64.5
Oxygen production (ton O_2/ha/year)	7.09	18.70
Leaf area index	7.3	5.6
Photosynthetic efficiency (%)	1.73	3.18
Radiation conversion efficiency (g/mj)	0.86	1.68
Total biomass in the area (ton/ha)	431	100
Incremental biomass (ton/ha/year)	5.8	8.3
Dry matter productivity (ton/ha/year)	25.7	36.5

Source: Henson (1999)

Carbon absorbed by oil palm plantations through the biosequestration mechanism is stored in the biomass of the oil palm plants themselves (above ground biomass). Furthermore, the sequestration process which takes place in the underground root system (underground biomass) is then stored in soil organic and inorganic carbon, better known as carbon stock.

The number of carbon stocks in oil palm plantations varies depending on various factors such as plant age, productivity, and plant population. Generally, the older the age of the oil palm plant is, the greater the carbon stock is (Singh *et al*., 2018; Lamade and Bouillet, 2015).

Chan's study (2002) revealed that the carbon stocks of oil palm plantations ranged from 16.12-45.28 tons of C/ha. The study by Kusumawati *et al*. (2021) showed that the carbon stocks of oil palm plantations ranged from 43.50-74.7 tons of C/ha. In addition, the study by Khasanah *et al*. (2019) also found that the average carbon stock of oil palm plantations was 40 tons of C/ha. The study by Setiadi *et al*. (2020) also found that the carbon stocks of oil palm plantations ranged from 34.16-69.32 tons of C/ha.

Carbon stocks are sequestered in oil palm plantation locations for up to 25-30 years. This is different from the carbon stocks of Industrial Forest Plantations (*Hutan Tanaman Industri*/HTI) which are harvested at less than 10 years of age. In fact, the capacity to absorb carbon dioxide from the Earth's atmosphere in oil palm plantations is greater than in mature tropical forests (Table 1).

The carbon stocks of oil palm plantations are an accumulation of the results of the CO_2 absorption process from the Earth's atmosphere and can be seen as part of climate change mitigation (PASPI Monitor, 2023[b]), namely reducing the concentration of CO_2 in the Earth's atmosphere. Therefore, carbon stocks in oil palm plantations can be traded in carbon trading.

Second, the scheme to increase the carbon stocks of oil palm plantations. Various technological innovations, when applied to oil palm plantations, can increase the carbon stocks of oil palm plantations. The technological innovations in question include management improvement, technological innovations to increase the productivity of oil palm plantations, as well as the integration of oil palm plants with forest plants, fruit plants, biochar technology, etc.

Through improved management and increased oil palm plantation productivity, carbon stocks or soil organic carbon will be increased (Rahman et al., 2021). It has been reported that the integration of oil palm plants with other plants (agroforestry) can also enhance the carbon stocks of oil palm plantations (Ahirwal et al., 2022). Biochar technological innovation for processing empty fruit bunches also increases carbon stocks (Noiret et al., 2022).

The growth of carbon stocks in oil palm plantations with management innovation, technology and diversification means an increase in the absorption of carbon dioxide from the Earth's

atmosphere. This is also part of climate change mitigation, namely reducing the concentration of GHGs in the Earth's atmosphere. Therefore, the growth of carbon stocks in oil palm plantations can also be traded in carbon trading.

Third, carbon emission reduction scheme. Although oil palm plantations have the ability to increase carbon stocks, the palm oil production process also produces emissions. According to the study by Mathews and Ardiyanto (2015), the largest contribution to emissions in the oil palm plantation production process to CPO Mill comes from (Figure 2): POME (62 percent), followed by fertilizer (31.5 percent) and fossil energy (5.1 percent).

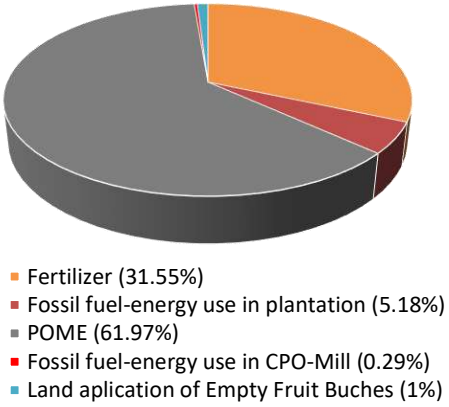

Figure 2. Main Sources of Emissions in Palm Oil Production

With various technological innovations, GHG emissions from the palm oil production process can be reduced. The application of methane capture technology for processing POME can reduce GHG emissions very significantly, reaching 66 to 90 percent (Mathews and Ardiyanto, 2015; Nisa and Wijayanti, 2023). Adoption of methane capture technology can significantly reduce CPO Mill emissions without affecting CPO production.

Fertilizer technology innovation can also reduce fertilizer emissions while increasing oil productivity. Fertilizer technology innovation in controlling release fertilizer (coating) can reduce fertilizer emissions by up to 50 percent (Sikora et al., 2020; IFA, 2022). Likewise, the substitution of inorganic fertilizer with biofertilizer also reduces GHG emissions from fertilizer without affecting plant productivity (Sun et al., 2021; Hidayat et al., 2023).

Based on various study results (Seng et al., 2021; Vincenza, 2021), it is evident that a combination of technological and management improvements can reduce GHG emissions in palm oil production (Figure 3).

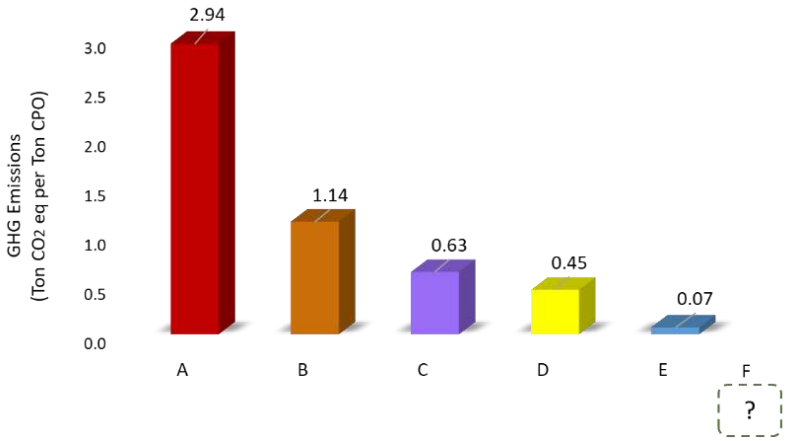

Figure 3. Emission Reduction Scenarios in Palm Oil Production with Various Technological and Management Innovations (PASPI Monitor, 2021; PASPI, 2023)

Notes:
A : Oil palm plantation + No Gap - No methane capture – No biomass energy
B : Oil palm plantation + GAP – No methane capture – No biomass energy
C : Oil palm plantation + GAP – Biomass energy - No methane capture
D : Oil palm plantation + GAP + methane capture - No biomass energy
E : Oil palm plantation + GAP + methane capture + biomas energy

Reducing GHG emissions by adopting technological innovations and palm oil production management is a part of climate change mitigation. This reduction in GHG emissions compared to the baseline has the potential to be traded in carbon trading.

With the three schemes above, it clearly shows that oil palm plantations are part of the solution in efforts to reduce GHG emissions in the Earth's atmosphere, both through the reabsorption of GHGs from the Earth's atmosphere (carbon stocks and carbon stock enhancement) and through the reduction of emissions in the palm oil production process. Therefore, oil palm plantations have the potential to participate in the developing carbon trading.

CONCLUSION

The global community that is part of the United Nations Framework Convention on Climate Change (UNFCCC) is committed to maintaining or reducing the GHG concentration in the Earth's atmosphere back to its natural concentration as a form of mitigation for global warming and global climate change. One of the efforts to reduce global GHG emissions initiated is through carbon trading.

Carbon trading basically adopts the Polluter's Pay Principles. If the amount of carbon emissions of the company concerned exceeds the carbon emissions permit that has been determined, then the company is obliged to offset its carbon emissions from other companies whose carbon emissions are below its permit. *Vice Versa*.

Oil palm plantations have quite large potential to participate in carbon trading. Three schemes for reducing global GHG emissions from palm oil plantations are carbon stock conservation, carbon stock enhancement, and emission reduction in the palm oil production process.

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