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Observations on Biodiesel Usage Trends in European Union

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Vegetable oils, used cooking oils (UCO), pine, tallow and animal oils were the main feedstocks to produce biodiesel in EU in 2011-2020. Rapeseed, palm oil, soya and sunflower were the four vegetable oils feedstocks and contributed to 67- 87 per cent of the total biodiesel usage. Although the amounts of biodiesel usage increased over time, the share of biodiesel from these four feedstocks relative to the total amount, decreased from 87 per cent in 2012 to 78 per cent in 2020. This loss was filled up by, principally, UCO, tallows, animal waste oils and greases; their amounts used increased by 2.5 times over the period. They will continue to be used in larger quantities in 2021-2030 and will cause the share of palm, soya and sunflower oils as biofuel feedstocks to decrease.

It is anticipated that vegetable oils will still be needed as biofuel feedstock in 2021-2030. With a significantly large share of 78 per cent of the total amount of biodiesel used in 2020, it will take some time before they can be replaced completely by UCO, tallows/animal waste oils and second to third generation biofuels. The call to determine the sustainability status of UCO more thoroughly in the future will also be expected to put some brakes on the accelerated use of UCO to replace these crop-based feedstocks.

The price of feedstock was of secondary importance when choosing the feedstock in 2012-2020. Rapeseed oil was the most expensive vegetable feedstock and yet it was the main feedstock used. This showed that other factors e.g., feedstock sustainability status as stipulated in the Renewable Energy Directive (RED) and local availability were also important; the European Union (EU)being the world's largest rapeseed oil producer. Besides, RED also stressed the importance of energy security and to provide jobs and economic development of the local people when executing the RE programme. As such, it is foreseen that rapeseed oil will remain the dominant feedstock.

However, vegetable oils have competing uses for food, feed, oleochemicals and biofuels. The ability to use rapeseed as the primary feedstock in huge amounts indefinitely has limitations. As a resource, rapeseed ranked third in quantity produced globally. Palm oil, followed by soya had the largest amounts of resource available for use in the world. Sunflower had the lowest resource availability among the four vegetable oils. As such, overstretching the use of rapeseed and sunflower for biofuel can have other dire consequences such as supply shortages and price increases.

Rapeseed alone cannot meet the total demand of EU's biodiesel needs. The study showed that even if the entire production of rapeseed oil from locally grown crop in EU was used for biodiesel production, it could only meet 58 per cent of its biodiesel demand in 2020. Since rapeseed feedstock cannot meet the total demand of biodiesel in EU, it is anticipated that in 2021-2030, it will have to be supplemented with other feedstocks particularly palm and soya oils. Under the Delegated Regulation, palm oil is classified as an unsustainable biofuel feedstock with high ILUC-risk. Incidentally, it is the only feedstock classified as such. It is, thus, envisaged that soya will be used in larger and larger amounts at the expense of palm oil. Under the Delegated Regulation the use of palm oil will be restricted starting in 2020 and continue until its use is phased out completely by 2030 at the latest. However, the tide may still change in favour of palm oil if its trade discrimination by EU can be stopped by World Trade Organisation where a trade dispute is ongoing currently.

Keywords: *Biodiesel, crop-based biofuels, vegetable oils, used cooking oil, resource availability, palm oil, rapeseed.*

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The need to address climate change is well accepted by the different nations in the world. As such, the Intergovernmental Panel on Climate Change (IPCC) (2018) has set the target to limit the rise of global world temperature to be lower than 1.5^{o} C above the pre-industrial level.

The leading cause of greenhouse gas (GHG) emission comes from the use of fossil fuels to generate energy for industrial use and transportation. This source alone contributes to 35 per cent of the total GHG emission in the world (IPCC, 2019). It is, thus, important to reduce GHG emission from this major source and biofuels are used in increasing amounts to achieve the purpose. Biofuels refer to liquid and gaseous fuels that are made from biomass (Kartan, 2017). Liquid biofuel, often known as biodiesel, is used primarily as a vehicle fuel in transportation.

Many countries in the world are replacing fossil diesel with biodiesel for vehicle use. Among them are Malaysia, Indonesia, Latin America, Japan, Korea, United States (US) and European Union (EU). The main feedstocks used to produce biodiesel vary in the different countries. For example, palm oil is the feedstock used in Malaysia and Indonesia (https://biofuels.news.com;https://www.reuters.com). In US and Latin America, the main feedstock is soya (FAO, 2013) while in EU it is rapeseed (Vedova, 2009).

Fossil diesel fuel can be easily replaced by biodiesel made from oils obtained from plant and animal fats. Palm, rapeseed, soya and sunflower are the common plant oils that are used and they are often referred to as vegetable oils as they have been used for a long time as food. It is also easy to divert them from food to biofuel feedstock use since these vegetable oil resources are easily available and abundant.

Biofuels are often classified into first, second and third generation biofuels. The first generation biofuels are simple, traditional biofuels that have been used for a long time. The second and third generation biofuels are currently in development. They are more complex, more advanced and more efficient than the first generation biofuels (Demirbas, 2009; Kartan, 2019).

The common first generation feedstocks are sugars, starches, vegetable oils and animal fats. They have been used for food, feed and oleochemicals for a long time. Second and third generation biofuels can be made from non-food crops, e.g. wheat straw, wood, solid wastes by using advanced technologies but most of them have not reached the stage to be commercially viable on a big scale (Demirbas, 2009; Kartan, 2019).

As a lot of first generation biofuel feedstocks sources are vegetable oils, they have attracted much attention in the food *versus* fuel debate (https://en.wikipedia.org › wiki › Food versus fuel). As such, their use as biofuel feedstocks are often despised. In this respect, the use of second and third generation biofuels are preferred since they do not compete with food use. In spite of these concerns, it is foreseen that first generation biofuels will continue to be used in the near future in EU due to the lack of second and third generation biofuels in large amounts.

EU and US are two countries that have dedicated programmes and mandates to use renewable energy (RE) or clean energy. In EU, the Renewable Energy Directive or RED was issued in 2009 to promote the use of energy from renewable resources for the period of 2010 - 2020 (European Commission, 2009). In 2018, RED was recast as RED II to set the direction for the period of 2021-2030 (European Commission, 2018). RED set the target to raise the share of RE use from

8.5 per cent in 2008 to 20 per cent in 2020. In RED II, the target was raised even higher whereby the use of RE will be increased to 32 per cent in 2030.

The transportation sector is considered to be a major player in the RE programmes. Ten per cent of the RE target is to come from this sector as part of the decarbonisation process under RED. It is also expected that most of the 10 per cent will come from the use of biofuels. In the implementation of RED II, at least 10 per cent of the transport fuels must come from RE. However, the use of crop-based biofuels shall not exceed 7 per cent.

This essay will examine the biodiesel usage in the EU for the period of 2012-2020 in order to identify trends in the usage. Based on these observations, an attempt is made to look at the scenario for 2021-2030.

TRENDS IN TYPES OF BIODIESEL FEEDSTOCKS USAGE

The biodiesel usage continued on an upward trend from 2012 to 2020. The results in *Table 1* obtained from USDA (2019) showed that 10.4 million tonnes were consumed in 2012 and this increased to 15.3 million tonnes in 2020 as seen in *Table 2* (Oil World, 2020).

During this period, the biodiesel feedstocks were oils derived from rapeseed, palm, soya, sunflower, used cooking oil (UCO), pine, tallow and animal wastes. The first four feedstocks are vegetable oils which are commonly used for food, feed and oleochemicals.

Biodiesel produced from these vegetable oils made up the major bulk of biodiesel used in 2012-2019 as seen in the results in *Table 1*. In the years of 2012, 2015, 2018 and 2019 respectively, 9.1, 9.5, 9.0 and 8.9 million tonnes were used. Their share to the total amounts of biodiesel were, thus, 87, 70, 67 and 68 per cent for the respective years. In 2020, 11.9 million tonnes of these vegetable oils were used and comprised 78 per cent of the total amount of biodiesel used. Hence, biodiesel made from vegetable oils contributed significantly to EU's RE programmes in 2012-2020 since they formed 67-87 per cent of the total biodiesel consumption. Although the amounts used decreased with time, they still constituted 78 per cent or more than three-quarters of the total biodiesel usage in 2020 according to the results in *Table 2*.

Among the four vegetable oils, rapeseed remained the leading biodiesel feedstock over the years. This was followed by palm, soya and sunflower oils in this order. In 2012, 6.5 million tonnes of rapeseed biodiesel were used, followed by palm oil, soya and sunflower biodiesels with 1.5, 0.7 and 0.3 million tonnes respectively. In 2019, 5.0, 2.6, 1.1 and 0.3 million tonnes of rapeseed, palm oil, soya and sunflower biodiesels respectively were used, according to the results in *Table 1* (USDA, 2019).This trend continued into 2020 according to Oil World (2020) results in *Table 2*.

Lower quantities of rapeseed feedstock were used as time progressed. In 2012, 6.5 million tonnes were used but the amounts dropped to 5.2 and 5.0 million tonnes in 2018 and 2019 respectively. Similarly, the usage of sunflower feedstock also decreased from 0.3 million tonne in 2012 to 0.2 million tonne in 2019 (*Table 1*). This trend of decreasing use of rapeseed from 2017 to 2020 was also reported by Oil World (2020) and seen in the results of *Table 2*.

On the contrary, the usage of palm oil feedstock bucked this trend and continued to increase over the years, from 1.5 million tonnes in 2012 to 2.6 million tonnes in 2019 (*Table 1*) or an increase of 73 per cent. The usage of soya feedstock also increased from 0.7 to

TABLE 1
AMOUNTS OF TYPES OF BIODIESEL FEEDSTOCKS USED IN EU IN THE RESPECTIVE YEARS

Amount of biodiesel feestocks used (x1,000 tonnes)	*Year*			
	2012	*2015*	*2018*	*2019*
Rapeseed	6500	6400	5200	5000
Palm oil	1535	2340	2570	2640
Soya	720	540	1000	1100
Sunflower	300	210	185	190
Used cooking oil	800	2400	2860	2750
Others	580	1590	1480	1500
Total	10435	13480	13295	13180

Note: 'Others' feedstock is made up of pine, tallow and animal waste oils
Source: USDA (2019)

TABLE 2
AMOUNTS OF TYPES OF BIODIESEL FEEDSTOCKS USED IN EU IN THE RESPECTIVE YEARS

Amount of biodiesel feedstocks used (million tonnes)	*Year*			
	2017	*2018*	*2019*	*2020*
Rapeseed	5.80	5.67	5.54	5.47
Palm oil	4.21	4.21	4.53	4.68
Soya	0.66	0.66	0.92	1.08
Sunflower	0.45	0.51	0.65	0.62
Used/waste oil	2.23	2.56	2.73	2.62
Others/tallows/greases	0.52	0.57	0.60	0.82
Total	13.87	14.18	14.97	15.29

Source: Oil World (2020)

1.1 million tonnes or 57 per cent during the period. This trend of increased use of both palm oil and soya feedstocks from 2017 to 2020 is also seen in the results in *Table 2* (Oil World, 2020).

Similarly, the results in *Table 1* show that there was a very large increase in the use of UCO, pine, tallow and animal waste oils for biodiesel production over the years. The use of UCO jumped from 0.8 to 2.75 million tonnes in 2012 to 2019 which was an increase of 3.4 times. From a percentage share of 8 per cent of the total biodiesel usage in 2012, this grew to 21 per cent in 2019. While it was the third major source of biodiesel in 2012, it climbed to second position in 2015 and continued to maintain this position in 2019. By doing so, it relegated palm oil to third position.

The use of feedstock composed mainly of pine, tallow and waste animal oils also increased 2.6 times, from 0.58 to 1.5 million tonnes during the period. From being the second last biodiesel feedstock in 2012, it inched its way to fourth position in 2015 and maintained this position in 2019. However, this

TABLE 3
ROTTERDAM PRICES OF VEGETABLE OILS FOR RESPECTIVE YEARS (USD/ MT)

Year	*2012*	*2015*	*2018*	*2019*	*2020*	*Average price for the five years*
Rapeseed	1240	775	833	853	906	921
Palm oil	999	622	598	566	751	707
Soya	1226	757	756	789	829	871
Sunflower	1263	846	750	739	880	896

Source: Oil World (respective years as mentioned in Table)

group of feedstock was made up of at least three different kinds of feedstock that included pine, tallow and animal fats.

The increased use of non-virgin vegetable oils which included UCO, tallows and greases is also seen in the results in *Table 2* (Oil World, 2020). The amounts of the use of non-virgin vegetable oils increased from 2.75 million tonnes in 2017 to 3.44 million tonnes in 2020, which was an increase of 125 per cent over the period.

The large increase in UCO, tallow and animal wastes to produce biodiesel is due to the fact that EU is moving away from the use of crop-based biofuels as feedstocks and promoting the use of feedstocks from wastes, animal fats and advanced fuels. This is clearly seen since RED allows the use of biodiesel made from UCO and animal fats to be double counted, meaning that one unit of volume used can count twice towards the target.

BIOFUEL FEEDSTOCK USAGE AND PRICE RELATIONSHIP

The choice of which biofuel feedstock to use was not directly related to its price. The results in *Tables 1* and *2* show that between 2012 – 2020, the largest amount of feedstock used was obtained from rapeseed. This was followed by palm, soya and sunflower in decreasing order.

The results in *Table 3* show that the rapeseed was the most expensive feedstock, followed by sunflower, soya and palm oil in descending price. The average prices of rapeseed, sunflower, soya and palm oil for this period were USD921, USD896, USD871 and USD707 per million tonne respectively.

Despite the fact that rapeseed feedstock was the most expensive, EU's RE programme was mainly supported by it. This showed that price was not the primary reason to determine its choice. Although EU is not the largest grower of rapeseed in the world, it is grown locally. There is also an abundant supply since EU is the largest producer of rapeseed oil in the world (USDA, 2021). The choice to use rapeseed over the other biofuel crops also fulfilled EU RED's agenda of ensuring energy security and to provide jobs and economic development for the local people.

The use of biofuels contributes to the decarbonisation agenda in EU. In this respect, RED had classified rapeseed, soya and sunflower oils as sustainable feedstocks by default as their individual greenhouse gas (GHG) emission savings were higher than the threshold value of 35 per cent savings that was needed to demonstrate sustainability.

Contrary to RED's labelling palm oil biofuel feedstock as unsustainable, many studies have shown that palm oil is a sustainable biofuel feedstock (van Zutphen & Wijbrans, 2011; van Zutphen *et al.*, 2011; Pehnelt & Vietz, 2013). All the studies showed that the GHG emission reduction savings of palm oil biofuel were way above its 19 per cent default value as published in RED. As a matter of fact, all these studies also showed that the GHG emission reduction savings of palm oil biofuel exceeded the threshold value of 35 per cent savings.

Despite RED classifying palm oil, that is produced by using the open effluent as an unsustainable feedstock, the Directive still allowed it to be used as a biofuel feedstock provided it underwent sustainability certification e.g. International Sustainability and Carbon Certification System (ISCC) to prove that the particular stock for use was sustainably produced. By doing so, palm oil became the second major feedstock to produce biodiesel. It was preferred as it was much cheaper than soya and sunflower feedstocks.

BIOFUEL FEEDSTOCK RESOURCE AVAILABILITY

Apart from price, the long-term availability of the resource/commodity has to be taken into consideration when executing a long-term RE programme. The setting up of biodiesel production plants are expensive and long-term availability of feedstock is important.

Vegetable oils and animal fats are resources that can be made into biofuels. A total of 17 oils and fats is readily traded and available globally, with an amount of 188.3 million tonnes in 2012 (*Table 4*). Their production increased steadily over the years and reached 236.0 million tonnes in 2020.

A total of 136.6 million tonnes of vegetable oils obtained from rapeseed, palm oil, soya and sunflower constituted 73 per cent of the overall total production of 17 oils and fats in 2012. Similarly, in 2020, 179.1 million tonnes of these vegetable oils were produced and comprised 76 per cent of the grand total. As nearly three-quarters of the total supply of oils and fats in the world come from these four vegetable oils, their importance as existing and future resources for biofuel production cannot be overlooked. The other 13 kinds of oils and fats together comprised about a quarter of the grand total production and, individually, each one of them will be unsuitable for use as a sustainable long- term biodiesel source due to its limited resource availability. There is also the possibility of price hikes due to competition for use as food or biofuel. This can happen when more and more of the limited resource is diverted from food to biofuel use.

Palm oil has the largest resource availability with a production of 74.1 million tonnes or 31 per cent of the total oils and fats in 2020. Soya is next with a production of 58.4 million tonnes or 25 per cent, followed by rapeseed 25.3 million tonnes or 11 per cent and sunflower 21.3 million tonnes or 9 per cent in 2020.

PROPORTION OF VEGETABLE OIL RESOURCES USED FOR BIODIESEL

Rapeseed, palm, soya and sunflower oils can be used for food, feed, oleochemicals and biofuel. How much of their available stocks were used for biodiesel production in EU in 2012-2020?

The results in *Table 5* show that the use of rapeseed as biodiesel consumed a fifth to a quarter of the world's rapeseed stock. These were 26.1 and 24.3 per cent in 2012 and 2015 respectively but dropped to about 20-22 per cent subsequently in 2018-2020. As such, an average of 23 per cent of the total stock of rapeseed oil present in the world was used for

TABLE 4
TOTAL PRODUCTION OF 17 OILS AND FATS IN THE WORLD FOR RESPECTIVE YEARS

	Global production (million tonnes)				
Year	*2012*	*2015*	*2018*	*2019*	*2020*
Rapeseed	24.9	26.3	25.5	24.9	25.3
Palm oil	53.9	62.6	74.7	76.1	74.1
Soya	42.8	48.9	56.4	56.8	58.4
Sunflower	15.0	15.2	16.9	20.5	21.3
Total (vegetable oils)	136.6	153.0	173.5	178.3	179.1
Grand total (17 oils and fats)	188.3	206.4	234.3	235.5	236.0

Source: Oil World (years as specified in Table)

TABLE 5
PROPORTION OF INDIVIDUAL VEGETABLE OIL STOCKS USED TO MAKE EU'S BIODIESEL IN DIFFERENT YEARS

	Proportion (%)					
Year	*2012*	*2015*	*2018*	*2019*	*2020*	*Average for the years*
Rapeseed	26.1	24.3	20.4	20.1	21.6	22.5
Palm oil	2.8	3.7	3.5	3.4	6.3	3.9
Soya	1.7	1.0	1.8	1.9	1.8	1.6
Sunflower	2.0	1.3	1.2	1.0	2.9	1.7

Notes:
i. Results in this Table are obtained by dividing the respective values from *Table 1* with those in *Table 4* and then expressed as % for the years of 2012-2019.
ii. For the year 2020, the results of *Tables 2* and *4* are used.
iii. Conversion factor: 1 tonne of vegetable oil can produce approximately 1 tonne of biodiesel

biodiesel in EU in 2012- 2020.

Palm oil's use for biodiesel drained off a small amount averaging 3.9 per cent of the resource in 2012-2020. As the amount of palm oil used for biodiesel kept on increasing during this period (*Tables 1 & 2*), this took away 2.8 per cent of the available stock in the world in 2012 and increased to 6.3 per cent in 2020. Similarly, the amounts of soya and sunflower used for biodiesel drained off very small proportions of their available resources which averaged 1.6 per cent for soya and 1.7 per cent for sunflower for the same period.

The larger the amount of siphoning of the existing stock of these vegetable oils, traditionally used for food, fuel and oleochemicals, for use as biofuel, the larger would be the shortage felt for traditional usages. The average proportions of total available resources used for biodiesel in EU were 22. 5, 3.9, 1.7 and 1.6 per cent for rapeseed, palm oil, sunflower and soya respectively as seen in the results of *Table 5*. This vacuum would have to be met by growing more of the crops which would lead to land use change effects and price increases. While the land use change effects were not studied here, the price increases from 2015 and 2020 were USD131, USD129, USD34 and USD72 per million tonne for rapeseed, palm oil, sunflower and soya respectively.

ABILITY OF VEGETABLE OIL RESOURCES TO WITHSTAND SCARCITY

Albeit increasing production of these four biofuel feedstocks in the future as a result of land expansion for cultivation and/or growing higher yielding crop varieties, their increasing diversion from food to fuel can put a strain on their availability and supply. As more and more existing stock is used as biodiesel feedstock, the supply for food becomes scarcer and scarcer.

The resilience of the individual feedstock to withstand supply scarcity shock is tested by finding out what proportion of its total stock present in the world is needed to supply EU's total biodiesel usage in 2020. Concurrently, therefore, what is the remaining proportion available for food and other uses?

Palm oil is the vegetable oil that was available in the largest amount in the world. In 2020, there were 74.1 million tonnes of palm oil in the world (*Table 6*). This quantity was 1.3, 2.9 and 3.5 times more than soya, rapeseed and sunflower respectively. Soya was the next largest available vegetable feedstock. With an amount of 58.4 million tonnes in 2020, this quantity was 2.3 and 2.7 times more than rapeseed and sunflower respectively.

The results in *Table 6* show that if palm oil was the only feedstock used in 2020, only 21 per cent of its total stock present in the world was sufficient to meet EU's total biodiesel demand for that year. A large surplus of 79 per cent still remained for food and other uses. If soya was used as the singular feedstock, 26 per cent of the world supply was enough to satisfy EU's total biodiesel usage in 2020. A large balance of 74 per cent of soya resource remained for food and other uses.

Due to the lower total physical amounts of both rapeseed and sunflower oils in the world, if EU had used them individually as feedstocks, more than half of their available stocks in the world would have been used up; these being 60 and 72 per cent respectively. As a result, low amounts of physical stock were left for food and other uses; these being 40 and 28 per cent for rapeseed and sunflower respectively.

As a matter of fact, the total demand of biofuel in EU in 2020 which amounted to 15.3 million tonnes could not be met alone by the entire production of 8.8 million tonnes (European Commission, 2020) from locally grown rapeseed. Similarly, the entire 4.0 million tonnes sunflower oil from locally grown sunflower plants managed to fulfill only 26 per cent of the total biodiesel demand. In both cases, rapeseed and sunflower oils obtained from plants grown in non-EU countries were needed to meet the shortages. It is, thus, seen that both rapeseed and sunflower oils cannot be used alone as biofuel feedstocks in large amounts without causing associated problems of their shortages and possibly price increases.

THE FUTURE

RE use will continue to increase in EU for the period of 2021-2030 as outlined in RED II. According to the Directive, at least 10 per cent of the transport fuels will come from RE. However, the use of crop-based biofuels shall not exceed 7 per cent of the gross 10 per cent for transport fuels.

This study shows that UCO feedstock had been increasing at a very rapid rate of 3.4 times

TABLE 6
PERCENTAGE SHARE OF DIFFERENT VEGETABLE OILS TO SUPPLY EU'S TOTAL BIODIESEL DEMAND AND BALANCE FOR NON-BIOFUEL USES IN 2020

Crop	*Total available stock in 2020 (MT)**	*Total biofuel usage in 2020 (MT)*	*Balance available for other uses in 2020 (MT)*
Oil palm	74.1	15.3 (21%)	58.8 (79%)
Soya	58.4	15.3 (26%)	43.1 (74%)
Sunflower	21.3	15.3 (72%)	6.0 (28%)
Rapeseed	25.3	15.3 (60%)	10.0 (40%)

Note: MT - million tonnes
Source: *Oil World (2020)

more from 2012 – 2019 and then remained at this high level in 2020 (*Tables 1 & 2*). The use of non-vegetable oils which included tallow and animal waste oils also increased during the period. The use of these oils will be expected to increase further in 2021-2030 as they continue to displace the use of crop-based feedstocks. However, the rate of displacement by UCO may be slower as there are moves calling EU to ensure that UCO imported for use in EU is fully traceable and sustainable (Transport & Environment, 2021). This will work out to the advantage of first generation crop-based biofuel feedstocks since their displacement by UCO will be slowed down.

More than half the amount of biodiesel used in 2012-2020 came from a combination of rapeseed, palm, soya and sunflower oils. Due to the large share, it is anticipated that it will take some time for them to be completely replaced by non-vegetable oils. As such, they will continue to be used in 2021-2030.

However, for the period of 2021-2030 when RED II is in force, palm oil feedstock will be disadvantaged. Based on the criteria laid down in a Delegated Regulation (European Commission, 2019) under RED II, palm oil is considered as an unsustainable biofuel feedstock, making it unacceptable for use under EU's RE programmes. Oil palm is the only crop yielding high indirect land use change (ILUC)-risk biofuel and thus subject to the freeze and phase-out. Rapeseed, soya and sunflower feedstocks are not classified as high ILUC-risk and can be used.

The setbacks on palm oil for use as a biofuel feedstock in EU are serious as seen in the following:

i) The level of consumption of palm oil biofuel feedstock in each member state shall not exceed or frozen at their levels of consumption in 2019 from 2020 and onwards.
ii) Starting from the end of 2023, palm oil's usage as a biofuel feedstock will be reduced and to reach zero percent by 2030 at the latest. This means that palm oil's use as biofuel will be phased out, at the latest, by 2030.

Palm biofuel will not be eligible for support schemes aimed at incentivising the use of sustainable biofuels.

Malaysia has engaged World Trade Organisation (WTO) in January 2021 for a trade dispute settlement regarding measures adopted by the EU and its member states that is affecting palm oil and palm crop-based biofuels. This is the second dispute complaint about the matter. Indonesia initiated dispute proceedings against the EU measures in December 2019.

Since the aims of EU's RE programmes are to lower GHG emissions, secure energy supply and to provide jobs and economic development locally, it is foreseen that rapeseed will continue to be the dominant biofuel feedstock that will be used. However, it has been shown in the earlier section that there is a limit to its availability if large stocks of rapeseed are continuously used for biofuel. This will likely result in its scarcity for non-biofuel use in the immediate short-term with possible associated problems of indirect land use change and price increases.

The inability to continuously use large amounts of rapeseed for biofuels will mean that biofuel feedstocks which are available in large amounts *viz*. palm oil and soya will still be needed to support EU's biodiesel programme in 2021-2030.

While palm oil was the second major feedstock in 2012-2020, its role will be diminished due to the Delegated Regulation. It is likely that soya will play a more prominent role and may displace palm oil to take second position.

Palm oil will still have a limited role to play until 2030 at the latest when its use as a biofuel feedstock in EU will be phased out completely. It has the advantage of being the cheapest biofuel and readily available. The outcome from the trade dispute settlement that is ongoing at WTO will decide the fate of palm oil as a biofuel feedstock in the long run. If the outcome is favourable for palm oil, it will likely remain as either the second or third major crop-based biodiesel feedstock for use in EU.

CONCLUSION

EU's RE programme for road transportation was carried out by using first generation biofuels in 2012-2020. More than half of the total amount of biodiesel used during this period was obtained by using four vegetable oils *viz*. rapeseed, palm, soya and sunflower oils as feedstocks, arranged in the order of decreasing amounts used. The share of this group of biofuel feedstocks decreased over the period from 87 per cent in 2012 to 78 per cent in 2020. This is in line with RED's proposition to reduce the use of virgin oils that are used for food and to use more waste oils and non-food based feedstocks. As such, the use of the latter feedstocks, principally, UCO, tallows, animal waste oils and greases increased nearly 2.5 times between 2012 and 2020.

Feedstock price was not the main determinant for use. Feedstock sustainability, energy security and provision of jobs and economy for the local people were more important. As such, although rapeseed was the most expensive feedstock, it was the dominant feedstock used. Rapeseed is home grown in EU and most abundant locally. Although EU is not the world's largest grower of rapeseed, it is the leading producer of rapeseed oil globally.

While the amounts of rapeseed biodiesel used in EU decreased over the period, that from palm and soya oils increased. Soya and palm oil biodiesels usage increased by 50 to 70 per cent respectively. As resources that can be used for food, feed, oleochemicals or biofuel, both palm and soya oils are available in very much larger quantities than rapeseed and sunflower. In fact, the study shows that EU's home grown rapeseed oil production could not even meet EU's total biodiesel requirement for the year 2020.

Unlike rapeseed and sunflower oils, palm and soya oils are, thus, in a better position to resist or weather declining stock supply shock when they face competition for use as biofuel, food and other uses. Thus, palm and soya oils will still have important roles to play to supplement rapeseed oil as biofuel feedstocks.

In line with EU's intention to limit crop-based biofuels, the use of spent or used cooking oils as well as oils from waste animal fats will continue to increase in 2021-2030. As such, there will be more usage of these oils to make biodiesel. For UCO, the calls to ascertain its sustainability are growing louder and may put some brakes on its rapid surge in use.

Vegetable oils have a large share or 78 per cent in the total biodiesel usage in 2020. Thus, it will take time for them to be completely phased out. Rapeseed will continue to be the leading feedstock followed by soya. The latter feedstock will replace palm oil which is classified as an unsustainable feedstock under the Delegated Regulation. The use of palm oil as a biofuel feedstock in EU will be restricted starting in 2020 and to be phased out completely by 2030 at the latest, unless the trade dispute that is happening in WTO concludes in palm oil's favour.

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