Jafari et al. Agricultural and Food Economics (2017) 5:13
DOI 10.1186/s40100-017-0083-z

Agricultural and Food Economics

RESEARCH Open Access

Risks and opportunities from key importers pushing for sustainability: the case of Indonesian palm oil

Yaghoob Jafari[1*], Jamal Othman[2], Peter Witzke[1] and Sufian Jusoh[3]

* Correspondence:
Yaghoob.jafari@ilr.uni-bonn.de
[1]Institute for food and resource economics, University of Bonn, Bonn, Germany
Full list of author information is available at the end of the article

Abstract

Growing concerns in the major importing countries on the socio-environmental sustainability of oil palm farming may affect the import demand of palm oil and hence the economy of the exporting countries. This paper develops a comparative static, partial equilibrium model to examine the impact of potential reductions in EU imports of Indonesia's palm oil on palm oil output, prices, factor markets, trade, deforestation, and peatland conversion in Indonesia. Results suggest that there would be only small impacts on the major environment-economic variables in Indonesia in a scenario with a moderate reduction EU import demand, for example, due to sustainability concerns. However, the impacts would be more profound if sustainability concerns also affect other import regions and trigger a similar decline in import demand in other markets. The way forward for Indonesia and other palm oil producers and exporters is to adopt a common set of sustainability criteria, encompassing the elements of transparency, regulatory compliance, best agricultural practices, environmental responsibility, the livelihood of small farmers, as well as human and community rights.

Keywords: Sustainable palm oil, Agricultural trade policy, Sustainability criteria, Forest conversion for oil palm, Trade-environment linkages, Indonesia

JEL classification: Q17, Q18, Q51, Q56

Background

The impact of trade on economic growth, poverty alleviation, and welfare of many resource-rich developing countries is beyond doubt. However, export growth also influences natural resource use and factor allocation. Mega-scale forest exploitation by large exporter countries which results in significant loss of biodiversity and climate change effects has now attracted increasing global attention and scrutiny. If these result in shifting consumer preferences or tighter legal regulations in view of sustainability concerns, substantial repercussions on trade flows and consequently the socio-economic conditions of the exporting countries might follow.

Global palm oil production has gained prominence over the past two decades, as it offers a number of competitive advantages over other competing oils, especially its lower cost and being free from trans-fatty acids. Global consumption of palm oil has also increased rapidly in the past decades, owing to its multiple uses both in the food industry as well as non-food sectors, including the biofuel industry.

A major share of the total palm oil production in the world comes from Indonesia and Malaysia, the largest producers of palm oil (Table 1). In 2011, palm oil production by Indonesia and Malaysia was respectively around 48 and 38% of global production. These two countries also accounted for 91% of world palm oil export. While exports of palm oil are dominated by two countries, imports are less concentrated. As indicated in Table 1, India and China are the largest importers of crude palm oil in the world, followed by the European Union (EU) where imports are for a number of uses and, in recent years, increasingly for biofuels.

The EU has aimed to increase its use of renewable energy from biofuels with one of the potential feedstocks being palm oil. However, it has been argued that the production of "palm oil-based biofuel" and associated conversion of forests and peatlands would cause even higher global emissions than those from the conventional fossil fuels that were supposed to be avoided (Butler 2008). Indonesia's oil palm growth has also been linked to forest fires that lead to transboundary smoke haze pollution. It is accepted that a large share of oil palm expansion in Indonesia occurred on converted forests and peatlands, however with some controversy on the exact magnitudes. Finally, the impacts of oil palm expansion on the livelihood of local and forest-based indigenous communities further fuel the debate on the socio-environmental sustainability of this development (German et al. 2011). Various agencies have suggested that the EU should impose restrictions on palm oil imports (Butler 2012; EurActive 2013). The Indonesian oil palm industry was reportedly alarmed by the possibility of the EU issuing more stringent sustainability requirements on companies exporting palm oil to EU member states. Any imposition of stricter standards may hamper increased imports of Crude Palm Oil (CPO) as a biodiesel feedstock, particularly from Indonesia (AsiaPulse News 2008; Butler 2008).

The EU effort was apparently directed to induce changes in oil palm farming practices, which was seen as a major source of deforestation, peatlands conversion, and climate change impact (Butler 2008). However, after the debate (and campaigns by the major palm oil producing countries), the European Commission (EC) in 2012 agreed to consider palm oil-based biodiesel as sustainable in the sense of the Renewable Energy

Table 1 World major players of palm oil, 2011

Producers and exporters					Importers		
Country	Production Share	Export Share[a]	Production[b]	Export[b]	Country	Import Share	Import[b]
Indonesia	0.476	0.445	23,900	17,200	India	0.171	6640
Malaysia	0.377	0.465	18,911	17,993	People's Republic of China	0.159	6165
Other countries	0.147	0.090	7369	3487	EU	0.142	5513
					Pakistan	0.051	1985
					Other	0.477	18,550
Source	Malaysian palm oil (2014a, 2014b)				Malaysian palm oil (2014c)		

[a]Includes re-exporting countries
[b]Thousand tons

Directive (Directive 2009/28/EC), if it is certified by the Roundtable on Sustainable Palm Oil (RSPO) scheme.

The RSPO was founded in 2004 specifically to promote the adoption of credible, global, and sustainability standards among palm oil growers via the engagement of multiple stakeholders and supply chain members. It promotes the use of the RSPO label to support palm oil plantations that have satisfied certain sustainability criteria. The move by the EC may boost the exports of RSPO certified palm oil into Europe, as palm oil may receive favorable treatment over other crop-based biofuels (Butler 2012), but the fraction of certified Indonesian palm oil plantations is still low (Focus 2016). The latest development on the issue is that the European Parliament's Environment Committee has agreed to support the EC to require companies to measure the amount of "indirect land use change" (ILUC) attributed to biofuel. This was taken despite the strong contention among palm oil exporter countries that the science on the climate impacts of ILUC has been inconclusive as well as the potential repercussions on food prices (Dave 2013).

The trade impacts of non-RSPO certified CPO being banned from the EU biofuel sector and additional ILUC constraints possibly reinforced are difficult to assess. In the past, companies have often found ways to circumvent binding restrictions. RSPO certification is only required for the biofuel sector but not for other uses. Given the aforementioned background, this study develops a comparative static, partial equilibrium model of the Indonesian palm oil sector with explicit linkages to key trading partners to appraise the impact on the major enviro-economic variables in Indonesia of a rather modest reduction in demand for Indonesian palm oil in the EU markets due to sustainability restrictions. The paper investigates the effects of this reduction in palm oil imports on Indonesia's oil palm growth, trade, and environmental impacts. Additionally, the study also considers the impact of a more drastic but rather unlikely scenario where all importers of Indonesia's palm oil are imposing similar sectoral and trade measures so that import demand from all importers would decline accordingly. Policy and management implications, with special emphasis on the roles of sustainability criteria and certification for palm oil producers, are the main topic for the concluding section of the paper.

Overview of the oil palm sector in Indonesia

Importance and dynamics of the sector

Panel *A* of Fig. 1 depicts the rapid expansion of Indonesia's oil palm planted area that was about 5.59 million hectares in 2013, increasing on average by 252,000 ha per year from 1995 onwards. Panel *B* of the figure also provides the trends of other crops that are basically stagnating, with a recent drop in sugar cane area apparently due to specific factors. A continuation of oil palm area expansion seems very likely, in response to population growth and policies that promote the use of palm and other oils in biofuels, despite the myriad of pressures and campaigns against oil palm expansion. However, a halt or slowdown of this trend by a potential imposition of more stringent sustainability requirements in major export markets might have far reaching implications on Indonesia's socio-economic development, global vegetable oil markets, as well as climate change mitigation.

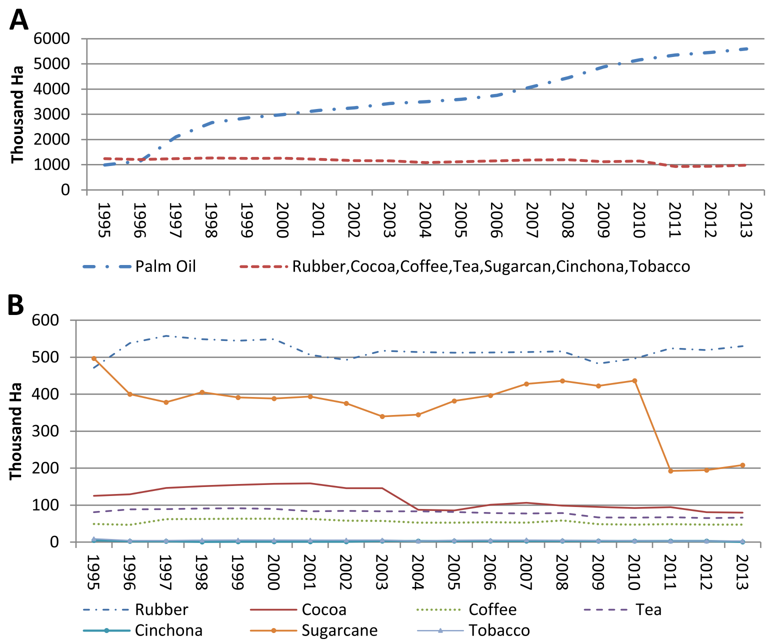

Fig. 1 Harvested area under palm oil and the main agricultural crops in Indonesia. *Data Source:* Department of Statistics, Indonesia (2016)

The rapid expansion of palm oil area has given rise to a sharp increase in production and exports of CPO from Indonesia. About 72% of Indonesia's CPO production is exported (refer to Table 1). In 2009, the largest share went to the Indian market (46%), followed by the EU (22%), and Malaysia[1] (11%) (See Table 2).

Environment and socio-economic aspects of palm oil production in Indonesia

Two of the most daunting challenges faced by the oil palm industry in Indonesia are deforestation and peatland destructions, which are associated with a high level of carbon emissions (Obidzinski et al. 2012). Replacing natural tropical forests and even secondary forest with oil palm also causes serious biodiversity loss in Indonesia (Koh and Wilcove 2008; Yaap et al. 2010). Obidzinski et al. (2012) report evidence suggesting that plantation development has even targeted forest land (as opposed to, say, shrub land) in Indonesia. It is critical and highly debated to which extent oil palm expansion resulted in deforestation and whether it has been the prime driver of deforestation

Table 2 Exports of Indonesian palm oil to destination markets, 2009

	India	Netherlands	Malaysia	Singapore	Italy	Germany, federated	China	ROW	Total
Export (kt)	4402	1057	1054	607	629	395	336	1087	9567
Share[a] of destination in Indonesian total	0.46	0.11	0.11	0.06	0.07	0.04	0.04	0.11	1
Share[b] of Indonesia in destination total imports	0.84	0.32	0.68[c]	–	0.49	0.46	0.44	0.09[d]	0.57

[a]Trade data (2010)
[b]Rifin (2010)
[c]Share for Malaysia is from palm data tracker: http://www.palmoilanalytics.com/data (and refers to 2009)
[d]Import of Singapore is included (Singapore just re-exports the CPO that has come from Indonesia or Malaysia)

(Casson 2000; Zakaria et al. 2007; Ministry of Environment 2009; Tan et al. 2009; Gibbs et al. 2010). In this study, we rely on Gunarso et al. (2013) who compiled detailed land use matrices and found that 1.1 Mha of forest land (of various types) and 0.7 Mha of peatland were converted to oil palm plantations in the decade 2000–2010 which represent 19 and 35% of the total deforestation and peatland conversion, respectively. This estimate ignores the possibility that conversion to oil palm plantations may occur via several interim steps (secondary forest, shrub land). Land converted from forest land to shrub land from 2000 to 2005 and then from shrub land to oil plantations between 2005 and 2010 is not part of the 19% share which only covers the direct conversion from forest to oil palm plantations. If we simply compute the ratio of additional oil palm expansion over the additional land conversions from 2000–2010 compared to 2000–2005 according to Gunarso et al. (2013), we would attribute 95% of forest conversion and 68% of peatland conversion to oil palm expansion, but we will mainly rely on the previously mentioned lower shares in the model specification to remain on the conservative side in terms of environmental impacts.

Another issue is the socio-economic impact of oil palm expansion on the rural community. It is generally accepted that oil palm plantations are an important source of employment in rural areas (Basiron 2007; Bunyamin 2008; Feintrenie et al. 2010). However, because oil palm cultivation requires a certain amount of experience and capital expenditures, Obidzinski et al. (2012) argue that these benefits seem to accrue to those endowed with a minimum level of income and agricultural skills, and hence, oil palm development is likely to benefit migrant smallholders with previous experience in oil palm plantation more than native people with no prior exposure.

Furthermore, oil palm plantations, especially large-scale estates, have frequently been associated with negative social impacts on rural communities and indigenous people (Telapak 2000; Marti 2008; Sirait 2009; Friends of the Earth Europe (FoE) (FoE) 2010). For example, oil palm development in Central Kalimantan has adversely affected the shifting cultivation practices of the local communities, causing food insecurity (Orth 2007). Marti (2008) found many cases of human rights abuse by plantation companies, especially during land acquisition and plantation development. Other studies indicate that conflicts occur due to a lack of recognition of customary rights, breached agreements, and disregard for the environment (Casson 2000; Colchester et al. 2006). As a consequence, various studies documented social conflicts between palm oil companies and local communities in Indonesia (McCarthy 2010; Colchester M 2010) that sometimes even led to companies ceasing operation (Obidzinski et al. 2012).

Overall, the push toward implementation of more stringent sustainability criteria may be expected to limit the expansion of oil palm plantation on peatlands and forests. Furthermore, as far as they also cover a comprehensive set of criteria relevant for human rights and social aspects, they might also improve the working condition of workers and reduce social conflicts.

Relevant sustainability standards for oil palm production

In Indonesia, three sustainability standards are particularly relevant: the Roundtable on Sustainable Palm Oil Standard (RSPO), the Indonesian Sustainable Palm Oil Standard (ISPO), and the Malaysian Palm Oil Standard (MSPO).

From the perspective of international trade, RSPO labeling can be categorized as a private "standard." RSPO is an international no profit organization that gathers different stakeholders in the palm oil supply chain to promote the use of sustainable palm oil production. RSPO generally focuses on sustainable production methods of oil palm. Private standards are not mandatory but they are becoming de facto an entry requirement for trading with many large-scale operators and leading value chains (Giovannucci and Purcell 2008).

However, Indonesia and Malaysia have opted to set up their own standards and product labels as an alternative to the RSPO standard and certification. ISPO is a mandatory standard in Indonesia while MSPO is not yet mandatory in Malaysia. But MSPO is also relevant for Indonesia as Malaysia is one of the major buyers of Indonesian palm oil. Table 3 compares the main areas of difference between RSPO, ISPO, and MSPO.

As shown in the table, ISPO and MSPO have less stringent criteria than RSPO, which in some instances requires companies to go beyond the national law. As a consequence, a reinforced application of the RSPO standard, for example, in Europe, would decrease demand from non-RSPO members even if Indonesian oil palm producers comply with their own, more lenient standard ISPO.

Methods

An analysis of how a shift in commodity export and/or import demand affects output price and quantity, primary factors demand, and ultimately forest and peatlands conversion requires knowledge of (i) trade policy-output supply linkages, (ii) linkages between the primary factor markets to output supply, and (iii) the relationship of total land demand to forest and peatland conversion that are thought to represent the key environmental variables linked to oil palm expansion in Indonesia.

In this study, we develop a comparative static, single-commodity model of Indonesian palm oil sector to capture the impact of a shift in export demand for Indonesian palm oil. In the model, CPO is exported to two markets−−the EU and the Rest of the World. Trade policy or consumer preference shocks affect CPO demand, supply, and as a consequence on the related demand for factors of production, land, labor, capital, and agrochemicals. In turn, changes in the demand for land in oil palm production affect forest and peatland conversion.

The modeling framework linking trade and environmental impacts in this study is a so-called market (equilibrium) displacement model as introduced by Muth (1964) and Floyd (1965). In general, it is a comparative static model based on total differentiation of a system of equations but manipulated to be expressed in terms of elasticities rather than slopes. Hertel used the approach in a model of a single farm sector that has become common in agricultural economics (see, for example, Hertel 1989; Alston et al. 1995; Gunter et al. 1996; Salhofer 1996; Jamal 1997; Alston and James 2002; Jamal 2003, Ciaian and Swinnen 2006; Ciaian and Kancs 2009; Jafari and Jamal 2015, 2016; among others). We develop a single commodity model similar to Hertel (1989) and apply this to the Indonesian oil palm sector.

For a comparative static analysis, the model is expressed in terms of variables which are all in percentage change, i.e, $\hat{D}_y^M = \frac{d\,D_y^M}{D_y^M}$, [2]see Jafari and Jamal (2015, 2016) for details of the mathematics. Table 4 depicts the symbols and descriptions for all

Table 3 Main areas of difference between ISPO, MSPO, and RSPO

	ISPO	MSPO	RSPO
Environment	Relies on national legislation	Relies on national legislation	Relies on a comprehensive guideline for compliance with environmental provisions
High conservation value land (HCV)	Requires HCV identification, but does not define identification procedures in details	Does not mention HCV protection	Requires HCV identification, and identification procedure is clearly defined
Peatland	Under specified conditions, planting on peatland is allowed	Developed guidelines for best practices on peatland	Encourages voluntary commitments to avoid planting on peatlands
New planting cutoff dates[a]	Does not provide a cutoff date	Does not provide a have cutoff date	It provides cutoff date
Social	Does not provide extensive social impact assessment requirements	Requires a social impact assessment and a system for complaints, but this is not outlined in details.	Requires comprehensive social impact assessment
Free, prior and informed consent (FPIC) standards	No explicit reference to this standard	Mentioned that FPIC shall be recorded	Provides detailed guidelines
Workers right	Does not have a requirement for employee/worker contracts. Employees/workers must be enrolled in the government's social security program.	Requires a policy on workers' rights, in accordance with national standards, and provides some detail on what this should entail.	Provides details guidelines on worker rights, health, and safety.
Compliance	Requires full compliance with all criteria	Requires that internal audit procedure are documented and evaluated, in order to implement necessary corrective action through continuous improvement action plans	Requires full compliance with all criteria

Source: Based on Effica (undated)
[a]A date after which new plantings should not replace primary forest or areas required to maintain HCV areas

Table 4 Definitions of variables of model

Endogenous variables	
D_y^M	Market demand for final output ($y = \text{CPO}$)
$D_y^{\text{EU}}, D_y^{\text{ROW}}$	Demand for y from EU and Rest of the World (ROW), respectively.
D_y^{Dom}, S_y^{Dom}	Domestic demand and domestic supply for y, respectively.
D_i , S_i	Derived demand for and supply of ith primary input
P_y^M	Market price of y
$P_y^{\text{EU}}, P_y^{\text{ROW}}$	Export price of y to EU and rest of the world (ROW)
$D_{\text{frst}}, D_{\text{ptls}}$	Demand for forest and peatland conversion, respectively
Parameters	
$\varepsilon_y^{\text{Dom}}$	Own price elasticity of domestic demand for y.
$\varepsilon_y^{\text{EU}}, \varepsilon_y^{\text{ROW}}$,	Export price elasticity of EU and rest of the world (ROW) demand for y.
σ_{ij}	Allen substitution elasticity between input i and j
$\alpha_y^{\text{EU}}, \alpha_y^{\text{ROW}}$	Share export demands from of EU and ROW for y in total market demand
α_y^{Dom}	Share of domestic demand for y in total market demand
c_i	The cost share of ith primary input with respect to total cost of producing y
v_i	supply price elasticity of ith input
γ, μ	Forest and peatland conversion elasticities with respect to total land demand, respectively.
Exogenous variables (policy shocks)	
U_y^{Dom}	Price equivalent shift factor in domestic demand schedules for y
$U_y^{\text{EU}}, U_y^{\text{ROW}}$	Price equivalent shift factors in EU and ROW export demand schedules for y

endogenous and exogenous variables in the model. The structure of the model which is specified for a long-run partial equilibrium model under the assumption of perfect competition in the market is given in Table 5.

Let D, S, and P refer to the demand, supply, and price of inputs or outputs, respectively. Subscripts y refer to output, while i and j refer to input quantities or prices. Superscript M refers to market quantities and domestic market prices such that P_y^M reads as price of market demand for y. Superscript Dom refers to domestic demand (or supply) while superscripts EU and ROW denote EU or rest of the world (ROW) export demand or prices. Parameters ε and α denote elasticities and market shares, such that $\varepsilon_y^{\text{EU}}$ represents the elasticity of EU demand for exports in response to changes in P_y^{EU}, while α_y^{EU} reads as the demand share of EU in total market demand.

Consider the final product (CPO) which is produced by firms in the domestic market and consumed by consumers both in domestic and foreign markets. Assuming that consumers have homothetic preferences, such that the market shares are parameters, Eq. (1) in Table 5 gives the change in market demand for the final product ($\hat{D}_y^M$) as a function of changes in domestic and export demands. Eqs. (2) through (4) describe the domestic and export demand responsiveness of prices. In this equation, U represents a shift factor in the demand schedule expressed in price equivalent form, and $\hat{U}_y^{\text{EU}}$ reads as the percentage shift for EU demand with the same impact as a price change of the same magnitude but opposite sign. The method of incorporating the shifters follows Jamal (1997 and 2003).

Equation 5 describes the derived demand for inputs i and j under locally constant return to scale. Output constant demand elasticities are then the product of their cost share (c) and the Allen partial elasticity of substitution (σ). Adding the output change effect gives the total change in input demand under locally constant returns (Eq. (5)). The

Table 5 Single commodity partial equilibrium model of the Indonesian oil palm

Commodity demand equations	
$\hat{D}_y^M = \left(1-\alpha_y^{EU}-\alpha_y^{ROW}\right)\hat{D}_y^{Dom} + \alpha_y^{EU}\hat{D}_y^{EU} + \alpha_y^{ROW}\hat{D}_y^{ROW}$	1
$\hat{D}_y^D = \left(\hat{P}_y^M-\hat{U}_y^{Dom}\right)\varepsilon_y^{Dom}$	2
$\hat{D}_y^{EU} = \left(\hat{P}_y^{EU}-\hat{U}_y^{EU}\right)\varepsilon_y^{EU}$	3
$\hat{D}_y^{ROW} = \left(\hat{P}_y^{ROW}-\hat{U}_y^{ROW}\right)\varepsilon_y^{ROW}$	4
Derived demand under locally constant return to scale condition	
$\hat{D}_i = \sum_{j=1}^{n} c_j\sigma_{ij}\hat{P}_j^M + \hat{S}_y^{Dom}$	5
Zero profit condition	
$\hat{P}_y^M = \sum_{i=1}^{n} c_i\hat{P}_i^M$	6
Input supply equations for two subsector	
$\hat{S}_i = v_i\hat{P}_i^M$	7
Forest and peatland conversion functions	
$\hat{D}_{Fst} = \gamma\hat{D}_{Land}$	8
$\hat{D}_{Ptls} = \mu\hat{D}_{Land}$	9
Factor market clearing conditions	
$\hat{D}_i = \hat{S}_i$	10
Commodity market clearing conditions	
$\hat{D}_y^M = \hat{S}_y$	11

next two equations describe the responsiveness of land and non-land input supply to a change in rents or return under the assumptions that $0 < \upsilon < \infty$. Equations 8 and 9 show forest and peatland conversion as functions of total demand for oil palm land, where the coefficients γ and μ represent the corresponding elasticities with respect to land supply for oil palm. In essence, these equations model the relative propensity of land supply from deforested land and peatland conversion due to increases in overall demand for land input. The last two equations describe the market clearing conditions, where any surpluses or deficits in inventory of palm oil outputs and inputs are assumed constant.

Mathematically, Eqs. (1)–(11) form a linear system that can be solved given the non-singularity of the related matrix of coefficients. Necessary and sufficient conditions for non-singularity are squareness of the system and linear independence of equations. The general system of algebraic equations can be represented compactly as $AX = C$. Here A is the Jacobian matrix (coefficients of the endogenous variables of the model), X represents the matrix of endogenous variables (prices and quantities) while the right-hand side matrix denotes the exogenous variables (policy shocks). Thereafter, we can apply Cramer's rule to solve for the endogenous variables.

Baseline parameters for the exogenous variables in the model

The baseline, exogenous parameters required to implement the model include the Allen elasticities of substitution between primary inputs, factor cost shares and supply elasticities, demand elasticity values, and responsiveness of conversion to total palm land use. These coefficients and parameters are crucial as the validity of simulation results depend on the representativeness of the values. The parameters including their sources for the 2009 base year are depicted in Tables 6 and 7.

Table 6 Allen elasticities and cost shares

	Land	Labor	Agrochemical	Capital
Land	*−0.3*	0.078	−0.042	0.645
Labor	*0.078*	−0.79	0.492	0.895
Agro chemical	−0.042	0.492	−1.007	0.378
Capital	*0.645*	0.895	0.378	−4.147
Factor cost share	*0.36*	0.31	0.19	0.14

Source: Rhomus (2006)

This study was fortunate to have access to the estimates of the Allen elasticities of substitution between primary inputs for the case of oil palm plantations in Indonesia's province of Riau. While recognizing that Indonesia is a large country with large differences among regions, we still consider oil palm production technology and management to be quite comparable across areas within the country. Hence, we take the estimates from Rhomus (2006) to be representative for substitution elasticities between the primary inputs for the entire country. Their pattern indicates in general a rather low substitutability between pairs of inputs (Table 6). This denotes there is only moderate scope for greater use of capital or mechanization at the farm level to sustain or generate output growth if land is not increased at the same time. The own price elasticity of land supply is also quite inelastic (0.3). Therefore, an export demand decline is likely to decrease demand (Eq. 5) for all inputs, but for land, the decrease in prices would be strongest. Changing land demand then leads to changes in forest or peatland conversion.

Model application

This study simulates two scenarios to examine the impact of a moderate reduction in export demand for Indonesian palm oil on selected economic and environmental

Table 7 Elasticity values, market shares, and conversion rates

	Variables description	Value	Sources
$\varepsilon_{y^{EU}}$	Palm oil own price demand elasticity in the European Union	−0.38	FAPRI (2013) elasticities database
ε_{y}^{ROW}	Palm oil own price demand elasticity in the rest of the world	−0.38	
$\varepsilon_{y^{Dom}}$	Palm oil own price demand elasticity in Indonesia	−0.38	
$\alpha_{y^{EU}}$	CPO export demand share of total output to EU markets	0.22	Calculated based on Trade data (2010)
α_{y}^{ROW}	CPO export demand share of total output to ROW markets	0.52	
$\alpha_{y^{Dom}}$	CPO domestic demand share	0.26	
v_{Land}	Elasticity of land supply	0.3	Salhofer (2000); Jafari and Jamal (2015, 2016, 2011); Jamal and Jafari (2011).
v_{Lab}	Elasticity of labor supply	0.55	
v_{Cap}	Elasticity of capital supply	2	
v_{Chem}	Elasticity of agrochemical supply	2	
γ	Elasticity of forest conversion with respect to oil palm expansion	0.19	Gunarso et al. (2013)
μ	Elasticity of peatland conversion with respect to oil palm expansion	0.35	

variables in Indonesia. The first scenario examines the impact of a 10% reduction in the price equivalent shift factor of the EU demand schedule for Indonesian CPO, which approximately corresponds to a 4% horizontal shift.[3] The second scenario considers the simultaneous impact of a 10% price equivalent demand shock on Indonesian CPO in the EU as well as in the ROW export markets.

These demand function shifters reflect changes in consumer preferences or the implementation of stricter legal sustainability criteria in the EU (or other markets) that would reduce the imports of palm oil from Indonesia. The second scenario is very pessimistic from the Indonesian perspective, but stronger impacts would also follow from a more drastic drop in EU demand, even if other regions would not reduce their import demand.

Results and discussions

The effects of both demand shocks on selected endogenous variables are listed in Fig. 2. The direction and magnitude of the changes in the variables are shown for each

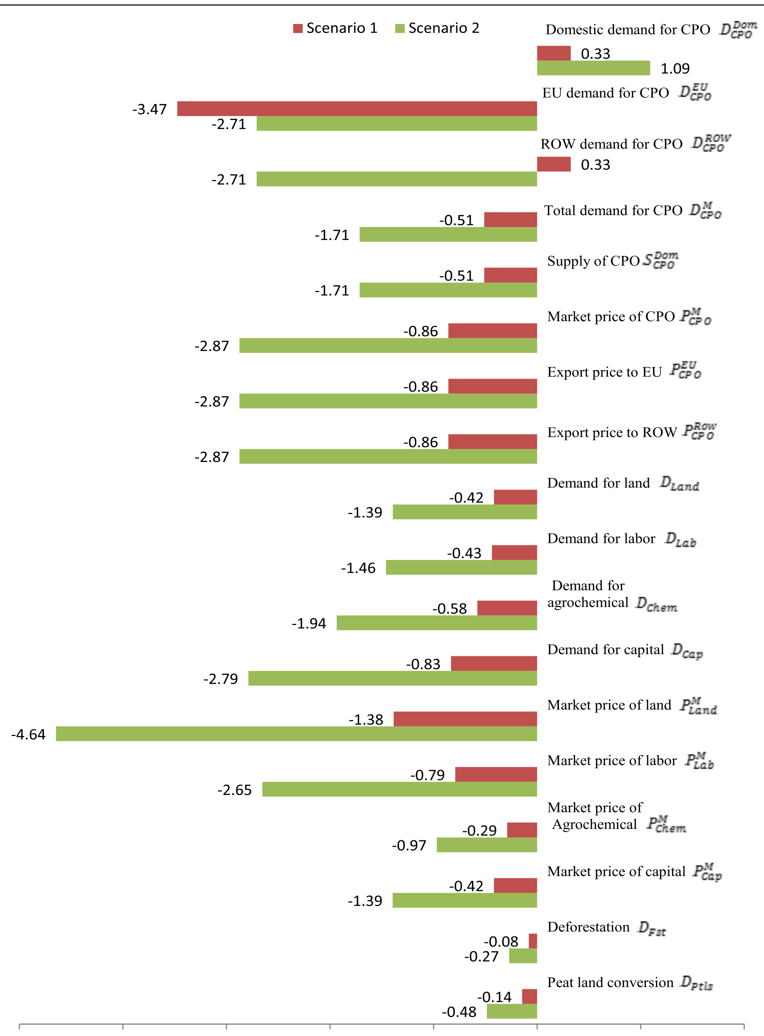

Fig. 2 Simulation results of export demand shocks on the palm oil sector of Indonesia, all given in percentage changes

scenario in a histogram with horizontal bars. Bars to the left show the reductions, and bars to the right show the increases of selected variables. The length of the bars indicate the magnitude of the changes. These changes should be interpreted as the percentage changes from a baseline trend, given the policy shocks, ceteris paribus. The simulated long-run impacts on the variables representing the output and input markets in Indonesia comply with expectations on their sign given the model structure. As can be seen in Fig. 2, based on the moderate reduction in export demand in both scenarios, palm oil supply, demand for inputs and the related conversion of forest and peatland would also decline only moderately.[4]

In the first scenario, equilibrium market and export prices decrease by −0.86% while export demand in Europe declines by −3.47%. The reduction in Indonesian export prices would provoke a minor increase in demand for CPO which is equal in magnitude (+0.33%) in the Indonesian domestic and rest of the world markets as demand elasticities have been assumed the same (−0.38, see Table 7). Our result is supported by Rina et al. (2010) who also expect that any reduction of Indonesian palm oil exports in European markets would be mitigated by increased exports elsewhere. However, according to our results, the increase in domestic and the ROW export demand for Indonesian CPO will not be able to completely compensate the reduction in European demand, and hence, total (market) demand for Indonesian CPO decreases. Consequently, the demand for land, labor, agrochemicals, and related capitals would fall as well. The reduction in agricultural land demand (−0.42%) would ultimately also reduce forest and peatland conversion by −0.08 and −0.14%, respectively.

For the second scenario, the direction of the impacts of the downward shift in export demand for Indonesian CPO on the variables of interest is the same as in the first scenario; however, the size of impacts is evidently larger. For instance, the modest decline in land demand in the first scenario (demand shock confined to the EU) would be reinforced from −0.42% to a more pronounced drop in land demand by −1.39% under the second scenario, hence more than double the previous impact. The impacts on land conversion would be, based on our assumed elasticities with respect to land demand, a decline of deforestation and peatland conversion by −0.27 and −0.48%, respectively, which are more than three times the impacts of scenario 1. The above results clearly confirm that a reduction in global demand would be only partially offset by increases in domestic demand in Indonesia. For this reason, this scenario has more sizable domestic impacts. Overall, the changes of the variables of interest are small, especially in the first scenario. Import restrictions decrease the overall import demand in both scenarios. The reduction is smaller in the first one because a part of the reduction in EU import demand is compensated by an increase in ROW demand. This reduction in import demand decreases market prices and consequently increases the domestic demand, but the net effects on total market demand and output are negative. Consequently, demand for primary factors of production, including the land input, declines, but this decline is more moderate than the reduction in outputs. Finally, the reduction in land leads to lower forest and peatland conversion rates.

Conclusions

The oil palm industry is a crucial element of the economy of Indonesia and a key export commodity. Sustainability concerns in importing countries and associated shifts in consumer preferences away from palm oil involve a risk to major exporters like Indonesia. In aggregate modeling, shrinking export markets would mean losses of export revenues and factor income, hitting vested interests of beneficiaries from the palm oil industry. However, only a fraction of global demand in terms of countries and single agents is likely to value sustainability higher than price competitiveness. Therefore, even a sizable demand shock in the EU would not warrant serious national concern, as Indonesia is likely to sustain her total exports to a large extent.

If import demand slows down, deforestation and peatland conversion would be slowed down as well. Environmental damage from deforestation and peatland conversion, including biodiversity loss and sizeable CO_2 emissions, could be alleviated. It is acknowledged that environmental effects do not only depend on land conversions but also on the management of oil palm production which is related to the use of agrochemicals and capital. But their use would even decline stronger than the land input in our scenarios such that the intensity of oil palm production would also be lower. However, any additional environmental benefits in terms of avoiding negative externalities could only be quantified with more disaggregate modeling approaches.

Coming to the socio-economic implications of these import restraint scenarios, we note that Indonesia would see income losses among migrant palm oil workers and, of course, among the owners of palm oil plantations. However, the economic dynamics of an expanding sector has also been linked by other authors to land ownership conflicts and other social problems. We might expect that these tensions in social relations and land ownership issues in rural communities would be moderated if their key economic stimulus is weakened. The downside socio-economic effects of a decrease in oil palm production are losses of employment, but these are unlikely to be serious for the resident rural poor population (in contrast to migrant workers).

However, non-negligible parts of Indonesian society would not welcome an import ban, in spite of some environmental benefits and positive socio-economic aspects. To avoid the pressure from important customers of palm oil producing countries, Indonesia (and Malaysia)[5] would, in turn, need to re-evaluate and realign their agri-environment policies, including international commitment to address emerging sustainability concerns which also covers socio-environmental sustainability of oil palm expansion. Some years ago, it appeared that the RSPO would simply need to raise its sustainability standards to resolve the matter decisively. However, the RSPO is no longer the sole flagship certification body for the global palm oil industry. Given the emergence of two national certification frameworks (ISPO and MSPO), it seems that the two major palm oil producers are taking separate ways in responding to the sustainability demands of affluent consumers.

A promising, perhaps optimistic way forward for Indonesia (and Malaysia) is to agree on a cooperative solution through a process that shall involve the various stakeholders within the palm oil sector. RSPO-certified palm oil has been well acknowledged by the EU, providing a ready platform for palm oil to make further inroads into the major affluent markets. Hence, it should be in the common interest of the ISPO, MSPO, and RSPO frameworks to adopt a shared set of sustainability criteria, encompassing the common elements of transparency, regulatory compliance, best agricultural practices, environmental responsibility, the livelihood of small farmers, as well as human and local community rights. This would provide a unified, credible, and globally accepted certification program that has good chances to avoid the pressure from declining export demand and, in the long run, even to support a further expansion. It would also pave the way for oil palm producers to have a common stance and stronger influence in related international forums and negotiations.

Endnotes

[1]Malaysia herself is one of the top CPO exporters alongside Indonesia. Due to increasing labor shortages and restricted land area in Malaysia, Malaysian oil palm companies have expanded to Indonesia and these Indonesian-based plantations are now exporting palm oil back to their home country.

[2]It is important to note that the *hat* notation symbolizes percentage changes in variables while *d* reflect the absolute changes in the variable)

[3]A 4% quantity shock is small compared to the standard error of Indonesian exports to major EU importers around the trend, which was 13% of the mean in the last decade.

[4]Note that the equations in the model have been linearized, and hence, the impacts of even higher demand shocks would be simply a multiple of the impacts shown below. For instance, a tripling in the demand shock would also give three times the impact of the original shocks. With higher shocks, though, approximation errors would be higher as well such that our scenarios were limited in scope on purpose.

[5]We refer to Malaysia as the shift in consumers demand preferences in Europe and other markets may not only affect Indonesia.

Acknowledgements
The authors would like to thank the two anonymous referees for their valuable comments.

Authors' contributions
YJ participates in the acquisition of data, development of the model, and drafting the article. JO makes a substantial contribution to conception and design of the paper and analysis of results. HPW revised the paper critically for important intellectual content. SJ makes substantial contributions to conception of the legal standing of standards in the article. All authors read and approved the final manuscript.

Authors' information
Dr. Y.J is a lecturer and researcher in the area of international trade modeling at Institute for Food and Resource Economics, University of Bonn, Germany.
Prof. Dr. J.O is a professor of Resource and Environment Economics Program in Faculty of Economics and Management, School of Economics, Universiti Kebangsaan Malaysia (UKM).
Dr. P.W. is a researcher with EuroCARE, an U Bonn spin off company specialized in quantitative economic research related to agriculture using the CAPRI model. Over various periods, he has worked in academic research for the Chair of Economic and Agricultural Policy of U Bonn.
Dr. S.J is a senior fellow at Institute of Malaysian and International Studies, Universiti Kebangsaan Malaysia. His expertise includes International Trade and Development, International Investment Policy, and International Law and Economic Law.

Competing interests
The authors declare that they have no competing interests.

Publisher's Note

Author details
[1]Institute for food and resource economics, University of Bonn, Bonn, Germany. [2]Universiti Kebangsaan Malaysia (UKM), Bangi, Malaysia. [3]Institute of Malaysian and International Studies, Universiti Kebangsaan Malaysia (UKM), Bangi, Malaysia.

Received: 7 April 2016 Accepted: 1 July 2017
Published online: 12 July 2017

References

Alston J M, James J S (ed) (2002) The incidence of agricultural policy. Handb Agric Econ 2B:1689-1749.

Alston JM, Norton GW, Pardey PG (1995) Science under scarcity: principles and practice for agricultural research evaluation and priority setting. Cornell University Press, Wallingford

AsiaPulse News (2008) EU's new regulation feared to ban CPO import from Indonesia. April 29, 2008.

Basiron Y (2007) Palm oil production through sustainable plantations. Eur J Lipid Sci Technol 109:289–295

Bunyamin B (2008) Dampak pengembangan PIR kelapa sawit terhadap perekonomian regional Kalimantan Barat [Impacts of oil palm plantations on the regional economy of West Kalimantan region]. Untan Press, Pontianak, Indonesia

Butler RA (2008) E.U. may ban palm oil biodiesel. https://news.mongabay.com/2008/01/e-u-may-ban-palm-oil-biodiesel/. Accessed 13 Oct 2011.

Butler R A (2012) E.U. OKs biofuels produced from certified palm oil. https://news.mongabay.com/2012/11/e-u-oks-biofuels-produced-from-certified-palm-oil/. Accessed 11 Mar 2013.

Casson A (2000) The hesitant boom: Indonesia's oil palm subsector in an era of economic crisis and political change. In: Occasional paper no. 29. Center for International Forestry Research, Bogor, Indonesia

Ciaian P, Kancs A (2009) The capitalization of area payments into farmland rents: theory and evidence from the new EU member states. In: EERI research paper series 04/2009. EERI, Brussels

Ciaian P, Swinnen JFM (2006) Land market imperfections and agricultural policy impacts in the new EU member states: a partial equilibrium analysis. Am J Agric Econ 88(4):799–815

Colchester M (2010) Land acquisition, human rights violations, and indigenous peoples on the palm oil frontier. Forest Peoples Programme, Moreton-in-Marsh, UK

Colchester M, Jiwan N, Andiko, Sirait M, Firdaus Y, Surambo A, Pane H (2006) Promised land: palm oil and land acquisition in Indonesia: implications for local communities and indigenous peoples. Forest Peoples Programme and Perkumpulan Sawit Watch, Moreton-inMarsh, UK and Bogor, Indonesia. http://www.forestpeoples.org/sites/fpp/files/publication/2010/08/promisedlandeng.pdf. Accessed 27 Nov 2016.

Dave Keating (2013) EENVI committee backs biofuel cap. http://www.europeanvoice.com/article/2013/july/envi-committee-backs-biofuelcap/77863.aspx. Accessed 31 July 2013.

Department of Statistics, Indonesia (2016) https://www.bps.go.id/. Accessed 20 Nov 2016.

Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC.

Effica (undated) Comparison of the ISPO, MSPO and RSPO Standards. http://www.sustainablepalmoil.org/wp-content/uploads/sites/2/2015/09/Efeca_PO-Standards-Comparison.pdf. Accessed 21 Aug 2016.

EurActive (2013) Indonesian palm oil faces EU bar over tax loophole. http://www.euractiv.com/development-policy/indonesian-palm-oil-faces-eu-bar-news-529579. Accessed 28 Dec 2013.

Feintrenie L, Chong WK, Levang P (2010) Why do farmers prefer oil palm? Lessons learnt from Bungo district, Indonesia. Small-Scale Forestry 9(3):379–396

Floyd JE (1965) The effects of farm price supports on returns to land and labour in agriculture. J Pol Econ 73(1965):148–158

Focus Asean (2016) How will Indonesia cope with slump in demand for palm oil? http://sea-globe.com/how-will-indonesia-cope-slump-demand-palm-oil/. Accessed 21 Aug 2016.

Food and Agricultural Policy Research Institute (FAPRI)––elasticity database. http://www.fapri.iastate.edu/tools/elasticity.aspx. Accessed July 31 2013.

Friends of the Earth Europe (FoE) (2010) Too green to be true: IOI Corporation in Ketapang District, West Kalimantan. Milieudefensie and Friends of the Earth Europe, Brussels, Belgium. http://www.foeeurope.org/publications/2010/Too_Green_to_be_True0310.pdf. Accessed 22 Sept 2016.

German L, Schoneveld GC, Pacheco P (2011) The social and environmental impacts of biofuel feedstock cultivation: evidence from multi-site research in the forest frontier. Ecol Soc 16(3):24

Gibbs HK, Ruesch AS, Achard F, Clayton MK, Holmgren P, Ramankutty N, Foley JA (2010) Tropical forests were the primary sources of new agricultural land in the 1980s and 1990s. Proc Natl Acad Sci U S A 107(38):16732–16737

Giovannucci D, Purcell T (2008) Standards and agricultural trade in Asia. In: ADB institute discussion paper no. 107. Asian Development Bank Institute, Tokyo

Gunarso P, Hartoyo M E, Agus F, Killeen T J (2013) Oil palm and land use change in Indonesia, Malaysia and Papua New Guinea. In T.J. Killeen & J. Goon (Eds.) Reports from the Technical Panels of the Second RSPO GHG Working Group, Roundtable for Sustainable Palm Oil––RSPO, Kuala Lumpur. http://www.rspo.org/key-documents/supplementary-materials with accompanying excel file. Accessed 26 Nov 2016.

Gunter LF, Jeong KH, White FC (1996) Multiple policy goals in a trade model with explicit factor markets. Am J Agric Econ 78(2):313–330

Hertel TW (1989) Negotiating reductions in agricultural support: implications of technology and factor mobility. Am J Agric Econ 71(3):559–73

Jafari Y, Jamal O (2015) A comparative statics, partial equilibrium, multi-commodity model for Malaysian agriculture. Malays J Econ Stud 52(2):2015

Jafari Y, Jamal O (2016) Impact of biofuel development on Malaysian agriculture: a comparative statics, multicommodity, multistage production, partial equilibrium approach. Food Energy Secur 5(3):192–202

Jamal O (1997) Linking factor markets, environment and trade: the case of oil palm in Malaysia. Jurnal Ekonomi Malaysia 31(1997):53–69

Jamal O (2003) Linking agricultural trade, land demand, and environmental externalities: case of oil palm in Southeast Asia. ASEAN Econ Bull 3(20):244–55

Jamal O, Jafari Y (2011) Effects of cooking oil subsidy removals on related markets: a comparative static, multi-commodity, multi stage production approach. Int J Manag Stud 18(2):121–144

Koh LP, Wilcove DS (2008) Is oil palm agriculture really destroying tropical biodiversity? Conserv Lett 1:60–64

Malaysian Palm Oil Board (2014a) http://econ.mpob.gov.my/economy/annual/stat2011/PDF%20FILE/WORLD/World6.9.pdf. Accessed 03 July 2014

Malaysian Palm Oil Board (2014b) http://econ.mpob.gov.my/economy/annual/stat2009/World6.8.pdf. Accessed 03 July 2014.

Malaysian Palm Oil Board (2014c) http://econ.mpob.gov.my/economy/annual/stat2009/World6.10.pdf. Accessed 03 July 2014.
Marti S (2008) Losing ground: the human rights impacts of oil palm plantation expansion in Indonesia. Friends of the Earth, Life Mosaic and Sawit Watch, London, UK
McCarthy JF (2010) Processes of inclusion and adverse incorporation: oil palm and agrarian change in Sumatra, Indonesia. J Peasant Stud 37(4):821–850
Ministry of Environment (2009) Report on the convention on biological diversity (the fourth national report). Ministry of Environment, Jakarta, Indonesia
Muth RF (1964) The derived demand curve fora productive factor and the industry supply curve. Oxf Econ Pap 16(2):235–261
Obidzinski K, Andriani R, Komarudin H, Andrianto A (2012) Environmental and social impacts of oil palm plantations and their implications for biofuel production in Indonesia. Ecol Soc 17(1):25
Orth M (2007) Subsistence foods to export goods: the impact of an oil palm plantation on local food sovereignty North Barito, Central Kalimantan, Indonesia. Sawit Watch, Bogor, Indonesia
Rhomus M (2006) Input substitution elasticities, technology changes and economics of scale: case study of oil palm in Indonesia, Ph.D dissertation (unpublished). Universiti Kebangsaan Malaysia, Bangi
Rifin A (2010) Export competitiveness of Indonesia's palm oil product. Trends Agric Econ 3:1–18
Rina O, Nur Rakhman S, Vanzetti D (2010) Indonesian agricultural trade policy at the crossroads. Paper presented at the 54th AARES Annual Conference. Adelaide, South Australia 10-12 February 2010.
Salhofer K (1996) Efficient income redistribution for a small country using optimal combined instruments. Agric Econ 13(3):191–199
Salhofer K (2000) Elasticities of substitution and factor supply elasticities in European agriculture: a review of past studies. In OECD.2001. Markets Effects of Crop Support Measures. OECD, pp. 89-110.
Sirait M (2009) Indigenous peoples and oil palm plantation expansion in West Kalimantan, Indonesia. Universiteit van Amsterdam, The Hague, the Netherlands
Tan KT, Lee KT, Mohamed AR, Bhatia S (2009) Palm oil: addressing issues and towards sustainable development. Renew Sustain Energy Rev 13:420–427
Telapak (2000) Planting disaster: biodiversity, social economy, and human rights issues in large-scale oil palm plantation in Indonesia. Telapak Indonesia, Bogor, Indonesia
Trade Data International (2010) An analysis of Indonesian exports of crude palm oil. http://www.tradedata.net/understanding-trade-statistics/. Accessed 21 Oct 2011.
Yaap B, Struebig MJ, Paoli G, Koh LP (2010) Mitigating the biodiversity impacts of oil palm development. CAB Reviews: perspectives in agriculture. Vet Sci Nutr Nat Resour 5(019):1–11
Zakaria A, Theile C, Khaimur L (2007) Policy, practice, pride and prejudice: review of legal, environmental and social practices of oil palm plantation companies of the Wilmar Group in Sambas District, West Kalimantan (Indonesia). Friends of the Earth Netherlands, Lembaga Gemawan, and KONTAK Rakyat Borneo, Amsterdam, the Netherlands