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Move Goods, Not Paper: the Carbon impacts of digitalising trade procedures

Evidence from the ePhyto case

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THE TIP OF THE SPEAR FOR DIGITAL TRANSFORMATION

$15m

investments in digital solutions

(31% of total Alliance investments)

22

projects completed

(47% of Alliance portfolio)

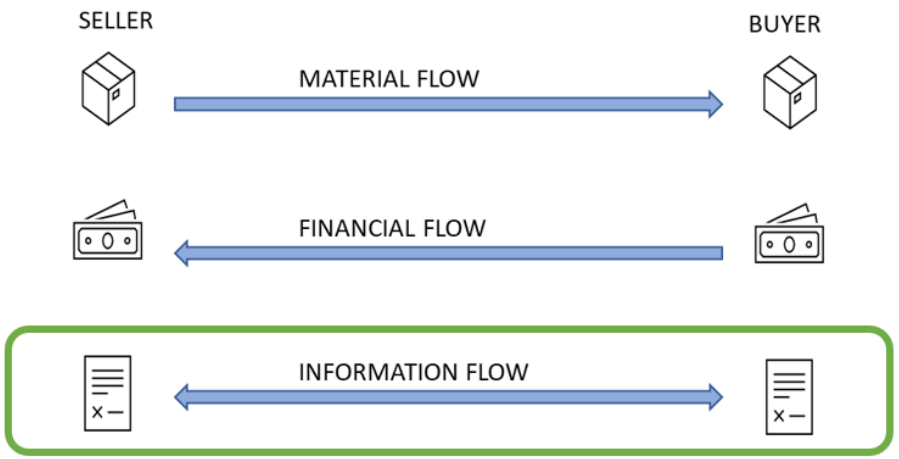
- e-Certification (14)
- Imp/Exp permits (2)
- SW enhancements (2)
- Port operations (2)
- Risk management (2)

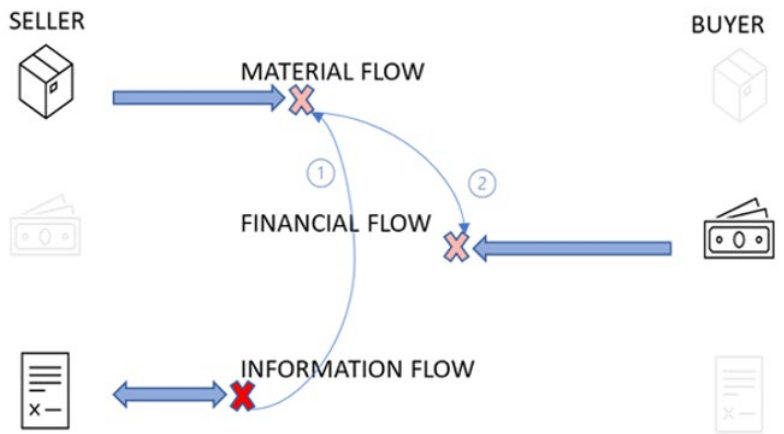
"How do we measure the impacts of trade facilitation projects on carbon emissions?"

Analytical approaches	Literature	Main takeaways
Economy-wide modelling (CGE)	Xiang et al. (2024); Narayanan et al. (2017)	Use computable general equilibrium (CGE) simulations to model the effects of trade facilitation on trade, GDP, and emissions. Show that while TF boosts activity, overall GHG effects depend on industrial mix and sectoral emission intensities. Capture *direction* but not *mechanisms* of change.
Border-level simulation	Reyna et al. (2016)	Use local traffic and inspection simulations (e.g., Mariposa border). Find that streamlining customs processes (e.g., adding lanes, FAST program) reduces congestion and idling, cutting GHGs locally. Results are site-specific and difficult to generalise.
Transaction-level analysis	Duval & Hardy (2021)	Quantify emissions per trade transaction by mapping procedural inputs. Offers a *bottom-up* framework linking procedural change to measurable CO2 savings — more suitable for project impact assessment.

OUR CONCEPTUAL STARTING POINT FOR MEASURING IMPACT

The components of a trade transaction

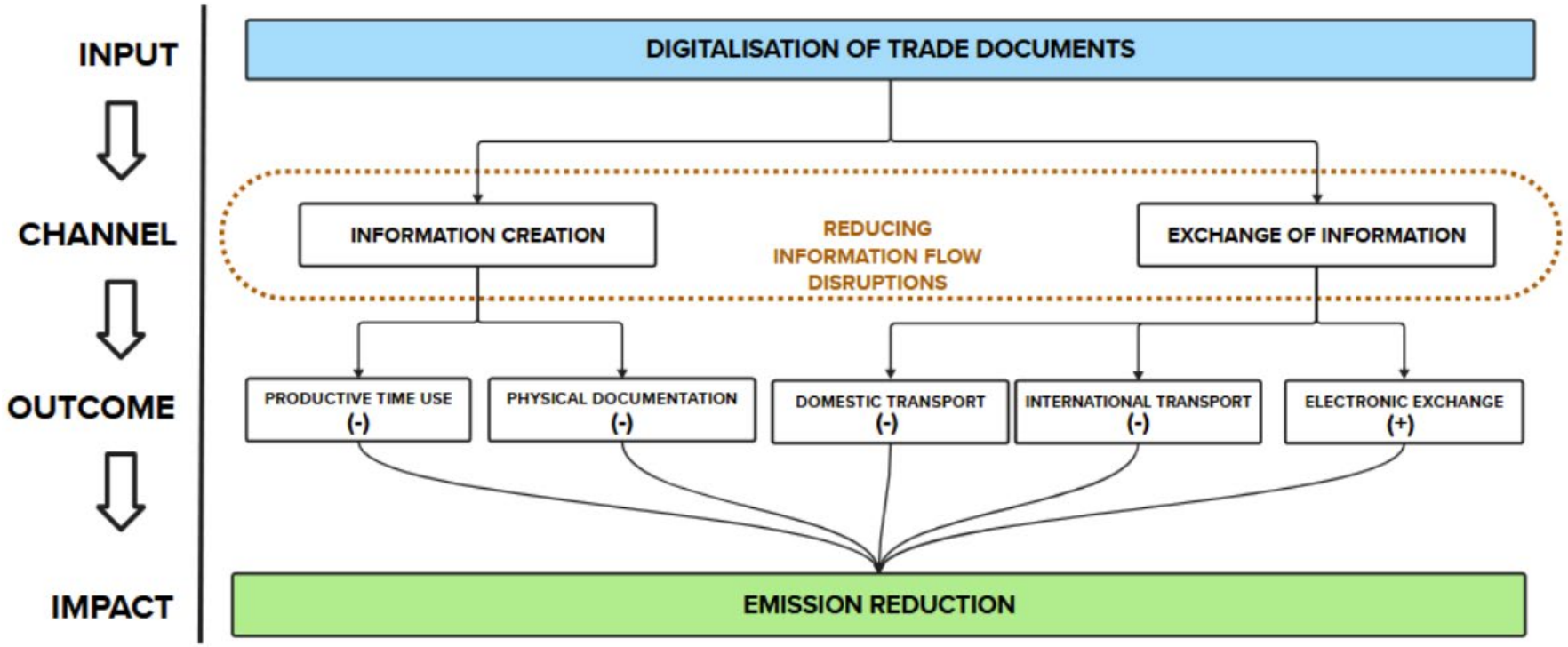




Trade facilitation measures typically involve streamlining compliance information creation and exchange.

... but also reduce information flow disruptions and make them easier to resolve.

Trade facilitation, digitalisation, and carbon emissions - What are the links?



Source: Author.

The ePhyto solution as a case study

WHAT IS A PHYTOSANITARY CERTIFICATE?

Official trade document certifying that a shipment of plant/products is pest-free (e.g. fruits, vegetables, wood, live plants, seeds,…)

Required to prevent spread of pest/diseases and protect agriculture/ecosystems in importing countries.

Document verified by border agencies (customs, plant protection agencies) upon import.

No.: 6816735

REPUBLIC OF INDONESIA
MINISTRY OF AGRICULTURE
INDONESIAN AGRICULTURAL QUARANTINE AGENCY

KT. 10

PHYTOSANITARY CERTIFICATE
No.: 2023.2.0303.0.K10.E.000997

Plant Protection Organization of Indonesia
to: Plant Protection Organization(s) of
CHINA

I. DESCRIPTION OF CONSIGNMENT

Name and address of exporter: [redacted]

Declared name and address of consignee: [redacted]
Dongcheng District, Beijing

Declared means of conveyance: MAIL EMS

Declared point of entry: BEIJING, CHINA

HS Code: 09012112, 09011130

Place of Origin: LAMPUNG

Distinguishing marks	Number and description of packages, name of produce, botanical name of plants		Quantity Declared
	1. Robusta Luwak COFFEE BEANS Coffea spp.	1 Bag, plastic	1,025.00 grams
	2. Robusta Luwak Roasted COFFEE BEANS Coffea spp.	2 Bag, plastic	540.00 grams
	Number of Commodities: 2	Total:	1,565.00 grams

II. ADDITIONAL DECLARATION
=== NONE ===

III. DISINFESTATION AND/OR DISINFECTION TREATMENT

Treatment: === NONE ===
Date: === NONE ===
Chemical (active ingredient): === NONE ===
Concentration: === NONE ===
Duration and Temperature: === NONE ===
Additional Information: === NONE ===

This is to certify that the plants or plant products or other regulated articles described herein:
- have been inspected and/or tested according to appropriate official procedures and
- are considered to be free from the quarantine pests specified by the importing contracting party and
- to conform with the current phytosanitary requirements of the importing contracting party, including those for regulated non-quarantine pests.

Name of authorized officer: KURNIA IRFANSYAH
Place of issue: JAKARTA
Date of issue: AUGUST 30, 2023

(Signature) (Name of Organization)

No financial liability with respect to this certificate shall attach to Plant Quarantine Service of Indonesia or any of its officers or representatives.

Printed 30/08/2023 10:44:03 - IQFAST v 4.6.0

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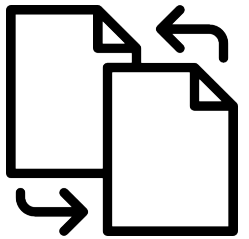
AND THE ePHYTO SOLUTION?

- Digitalises administrative procedures for obtaining the certificate.

- Enables its electronic exchange between various supply chain stakeholders.

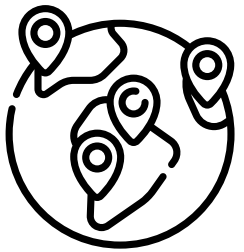
- It allows exporters to request modifications to the certificate online, when needed*.



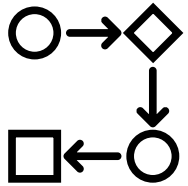
*For example, there is a change the name of the buyer, or have clerical errors, …

OUR APPROACH TO THE STUDY

- We surveyed 258 firms in 10 countries where the Alliance supported the implementation of the ePhyto solution.



- We collected detailed data on phytosanitary procedures and compliance.



- To estimate impact on emissions, we compare the carbon footprints of paper-based and electronic procedures.

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COMPARING PAPER-BASED AND EPHYTO SYSTEMS

Table 1: Comparing paper and digitalised phytosanitary procedures

Stylised phytosanitary procedures	Paper-based system	ePhyto system	Impact channel	Outcome
Preparing an inspection/ certificate request	Operators may be required to fill a paper form to request an inspection through a paper form, in person, at the NPPO office.	Operators fill in an inspection/certificate request online	Information creation	(-) Physical documents (-) Working time
Submitting of inspection/ certificate request	Operators submit an inspection/certificate request through a paper form, in person, at the NPPO office.	The inspection/certification request is transmitted electronic	Information exchange	(-) Domestic exchange (+) Electronic exchange
Conducting a phytosanitary inspection	NPPO inspectors physically travel to the premises of the operators to conduct an inspection. The inspection report is issued on paper	NPPO inspectors physically travel to the premises of the operators to conduct an inspection. The inspection report in completed electronically.	Information creation	(-) Physical documents
Issuing a certificate	Phytosanitary certificates and relevant annexes are signed and issued by the NPPO on security paper, used for official purposes.	ePhytos and relevant annexes issued electronically by the NPPO	Information creation	(-) Physical documents
Retrieving a certificate	Signed phytosanitary certificates are retrieved, in person, by the operator or their representative, at the NPPO office.	Operators may download a PDF version of the certificate on the ePhyto platform	Information exchange	(-) Domestic exchange (+) Electronic exchange
Transmitting a certificate	Certificates are transmitted by air courier – either with the goods or separately to the buyer.	Certificates are transmitted automatically to the NPPO of the destination country after approval. Operators can send the PDF version of the certificate to the buyer via email.	Information exchange	(-) International exchange (+) Electronic exchange
Stylised certificate replacement procedures	**Paper-based system**	**ePhyto system**	**Impact channel**	**Outcome**
Submitting replacement certificate request	Operators request the replacement of an existing phytosanitary certificate, in person, at the NPPO office.	Operators have to request an amendment of an existing phytosanitary certificate electronically via the ePhyto platform.	Information disruption Information exchange	(-) Domestic exchange (+) Electronic exchange
Issuing a replacement certificate	The NPPO in the country of origin invalidates the original certificate and issues a replacement	The NPPO staff in the country of origin can review and approve the request for amendment via the ePhyto platform.	Information disruption Information creation	(-) Physical documents
Transmitting a replacement certificate	The replacement certificate is sent by air courier to buyer in the country of destination.	The approved amendments are automatically transmitted to the NPPO at the country of destination .	Information disruption Information exchange	(-) International exchange (+) Electronic exchange

Source: Author's illustration.

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KEY RESULTS

8.4 $kgCO_2e$ per certificate

The estimated carbon emission saving per certificate by adopting the ePhyto solution.

Of this estimated value (8.4 $kgCO_2e$), here are the contributing factors:

80%

Domestic exchange of information

Fuel used for transport to complete phytosanitary procedures – e.g. submitting-retrieving documents.

17%

International exchange of information

Fuel used to transmit phytosanitary documentation from seller and buyer by express courier.

3%

Use of productive hours

Energy used for office environment for completing administrative task related to phytosanitary documentation.

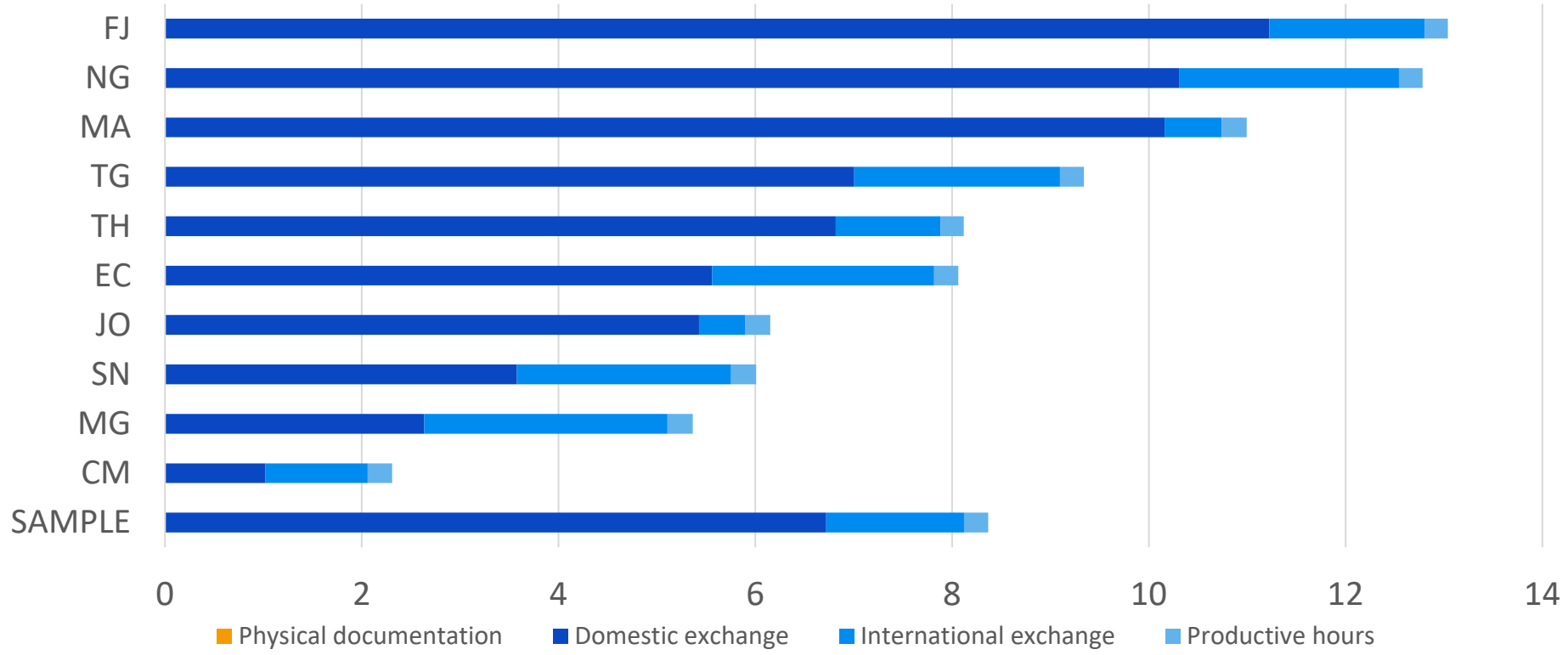
0.1%

Paper documentation

Energy used to produce a sheet of paper, ink and electricity for printing.

There are disparities in the carbon-intensity of phytosanitary procedures across countries.

Estimated carbon emissions savings by adopting the ePhyto, by country (in $kgCO_2e$/certificate)



Notes: CM = Cameroon; EC = Ecuador; FJ = Fiji; JO = Jordan; MG = Madagascar; MA = Morocco; NG = Nigeria; SN = Senegal; TH = Thailand; TG = Togo.
Source: Author.

Estimated cumulative carbon emissions savings (Jan. 2018 – Dec. 2024)

Cumulative estimates	Number of certificates exchanged	tCO2e saved	Trees required to match these savings*	Number of flights (NYC-LDN)**
January 2018 - December 2024	7,690,036	64,290	2,922,286	108,967
Forecast (Dec 2027)	17,360,842	145,140	6,597,283	246,000
Lower bound	14,916,276	124,703	5,668,325	211,361
Upper bound	19,805,408	165,577	7,526,241	280,640

Notes: Based on the number of ePhytos exchanged through the IPPC Hub. Forecasted values estimated through least square regression, with 95% confidence interval; *On average, one mature tree can absorb about 22 kilograms of CO2 per year; **A one-way flight for one passenger is estimated to generate 0.59 tonnes of CO2. Source: Author

FACTORS INFLUENCING CARBON ESTIMATES

OVERestimation Factors

Factors	Description	Effect on Results
Partial or inconsistent adoption	Some border agents or importing countries still require paper certificates despite digital connections.	Recorded as digital but paper still used → *overstates realised savings*.
Firm risk aversion	Exporters may continue printing certificates to avoid clearance risks or reputational costs.	Reduces actual uptake of paperless processes → *overstates savings*.
Transit through non-digital countries	Shipments passing through countries not using ePhyto require paper reissuance.	Maintains partial paper dependency → *overstates savings*.
Multiple certificates per shipment	Some firms request several certificates at a time.	Inflates “per certificate” efficiency → *overstates savings*.

FACTORS INFLUENCING CARBON ESTIMATES

UNDERestimation Factors

Factors	Description	Effect on Results
Limited data coverage	Only includes certificates exchanged via the IPPC Hub; excludes government-to-government or regional exchanges (e.g. ASEAN Single Window).	Misses part of existing ePhyto adoption → understates total savings.
Omitted emission sources	Assumes standard paper; does not account for higher footprint of security paper used for official certificates.	Underestimates true baseline emissions → understates savings.
Narrow analytical scope	Focus on information flows, excluding indirect benefits from reduced clearance delays, spoilage, or improved logistics.	Ignores secondary efficiency and energy savings → understates benefits.

Solving compliance issues and logistical inefficiencies

- Issues with phytosanitary documentation upon arrival can delay unloading procedures for cereals/grain (source: GIZ-Morocco).
- Such delays can increase ship turnaround times for days.
- A 25,000 DWT bulk carrier can emit approx. 4.3t CO_2 per day while berthed.
- Adopting the ePhyto solution can minimize the occurrence of related delays.

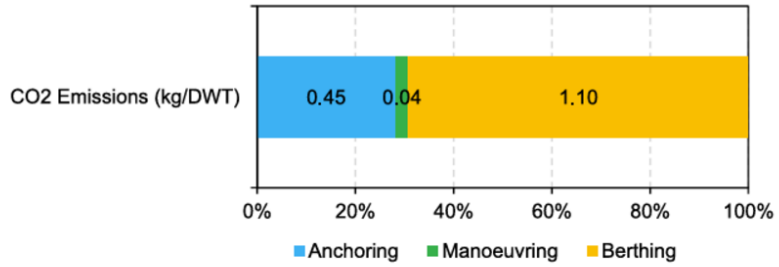
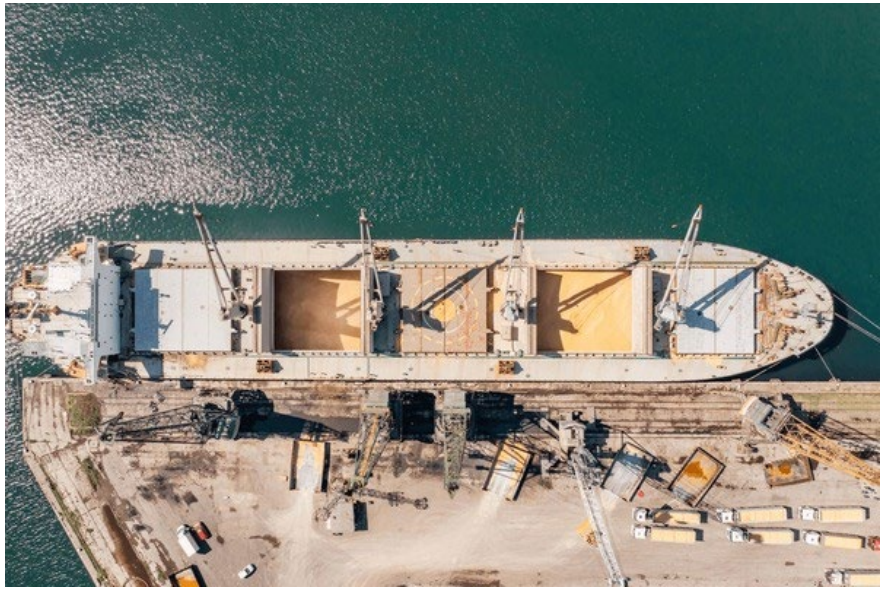


Fig. 8. The contribution of CO_2 emissions for ship activity.



Solving compliance issues and product spoilage

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Business News › News › Economy › Foreign Trade › A case of exporting mangoes: US junks 15 Indian shipments over lapses in documentation

ETPrime

A case of exporting mangoes: US junks 15 Indian shipments over lapses in documentation

By Shantanu Nandan Sharma, ET Bureau • Last Updated: May 18, 2025, 05:30:00 AM IST

Synopsis

US authorities rejected at least 15 shipments of Indian mangoes due to documentation errors related to mandatory irradiation, despite the process being overseen by a USDA officer in Mumbai. Exporters face potential losses of $500,000 as they are forced to destroy the perishable cargo, disputing claims that the treatment wasn't completed and highlighting discrepancies with the PPQ203 form.

Source: https://economictimes.indiatimes.com/news/economy/foreign-trade/a-case-of-exporting-mangoes-us-junks-15-indian-shipments-over-lapses-in-documentation/articleshow/121240972.cms?from=mdr

THREE KEY TAKEAWAYS

1. Trade facilitation policies and investments in digital infrastructure can have an impact on sustainability.
2. Procedures around obtaining and transmitting paper are more carbon-intensive than the paper itself.
3. We're only looking at the tip of the iceberg: the interaction between facilitated compliance procedures and more efficient logistical operations may unlock greater environmental benefits.

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THANK YOU

FOR MORE INFORMATION ABOUT OUR STUDY
www.tradefacilitation.org/our-papers/

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