



**QUEEN'S
UNIVERSITY
BELFAST**

**THE INSTITUTE
FOR GLOBAL
FOOD SECURITY**



**Thammasat University
Center of Excellence in
Global Food Security**

The challenges and Opportunities of Deforestation Legislation

Yuhne Hong¹, Maria Aparicio Muriana¹, Nick Birse¹, Chris Elliott ^{1,2}

1. Institute for Global Food Security, Queen's University, Belfast
2. Center of Excellence in Global Food Security, Thammasat University (Rangsit Center), Pathum Thani 12120,

Deforestation and Food Production

Five key issues and how they are connected

1

Agricultural expansion

Forests are cleared to create space for cropland and pasture, especially for commodities such as cattle, soy, palm oil, cocoa and other crops.



2

Biodiversity and ecosystem loss

Forest clearance destroys and fragments habitats, threatening wildlife and reducing vital ecosystem services such as pollination, water regulation and soil protection.



5

Supply chain, trade and food security risks

Commodities linked to deforestation face increasing traceability, regulatory and market pressures. Ensuring deforestation-free supply chains is becoming more important, as forest loss can also undermine long-term food security by damaging the natural systems that agriculture depends on.



FORESTS
CLEARED
FOR FOOD
PRODUCTION

3

Climate change

Clearing and burning forests releases stored carbon and removes an important carbon sink. Agricultural expansion can create a feedback loop, where deforestation contributes to climate change, which in turn increases risks to food production.



4

Soil and water degradation

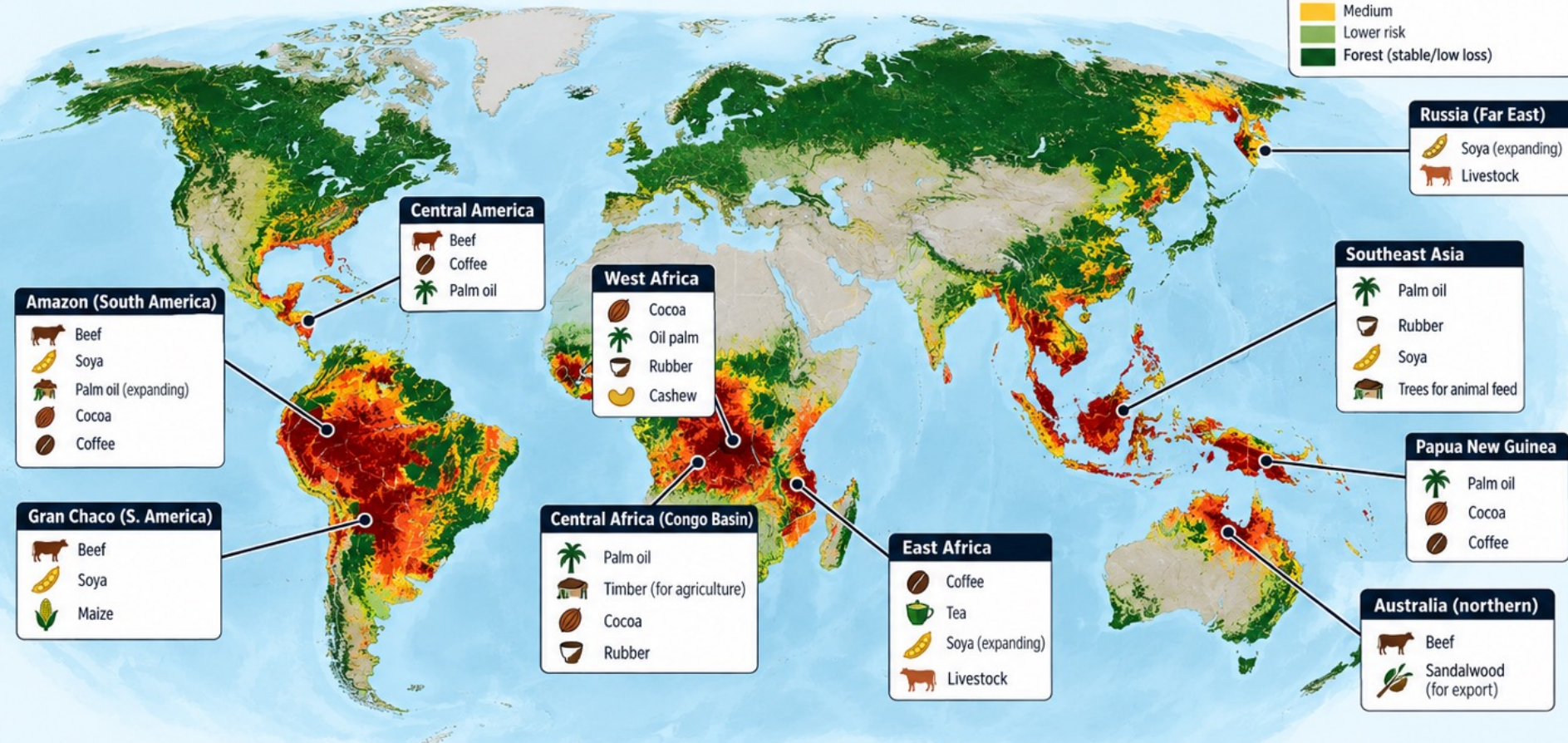
Removing forests increases soil erosion, nutrient loss and sedimentation, and disrupts local and regional water cycles. This can reduce soil fertility, water availability and long-term agricultural productivity.



Global hotspots: where deforestation is linked to food production

Forests are being cleared worldwide to produce key agricultural commodities for domestic use and international trade.

Deforestation risk (forest loss, 2001–2023)

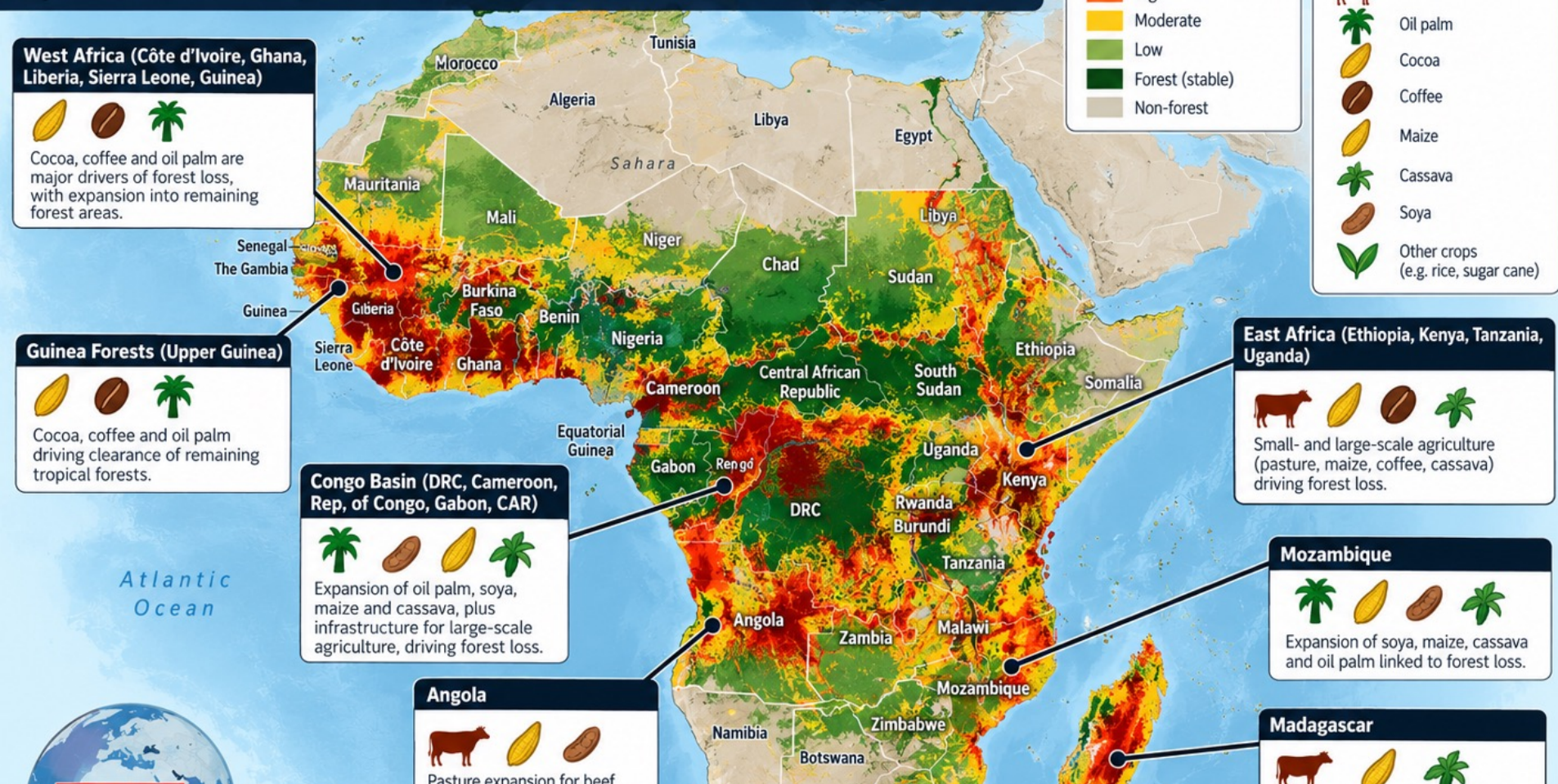


Key food commodities associated with deforestation



Deforestation in Africa linked to food production

Key areas of forest loss (2001–2023) and the main food commodities driving clearance



The EU Deforestation Regulation (EUDR)

Five ways EUDR helps tackle deforestation and support more sustainable food systems



1 Keeps deforestation out of EU supply chains

Prevents products linked to recent deforestation from being placed on the EU market or exported from it.



2 Targets key commodity drivers

Covers the main commodities linked to deforestation.



Cattle



Cocoa



Coffee



Oil palm



Soy



Rubber



Wood

3 Makes traceability central

Requires geolocation data and due diligence to show products are deforestation-free and legally produced.



4 Turns forest protection into a market-access requirement

Access to the EU market depends on compliance, creating a strong incentive to protect forests and reduce greenhouse-gas emissions.



5 Could influence production beyond Europe

Drives greater traceability and deforestation-free production in producer countries, raising global standards and supporting forest conservation.



From **voluntary** to mandatory

EUDR may be the start of a global shift towards deforestation-free supply chains



EUDR: Key Challenges for Africa

Important risks for African food and forest supply chains

1 Risk of exclusion for smallholders

Many smallholders may be unable to provide geolocation and traceability data, risking loss of access to the EU market.



3 Weak infrastructure and data systems

Incomplete land records, informal supply chains and limited digital connectivity make proof of origin difficult.



5 Burden on farmers versus unequal benefits

Farmers may bear much of the compliance burden, while downstream businesses



2 High cost of compliance

Mapping farms, data collection, verification and administration can be costly, especially for fragmented supply chains.



4 Risk of trade displacement

Non-compliant production could be redirected to other markets rather than stopping deforestation, creating a two-tier global market.



EUDR: Major Opportunities for Africa

Supporting sustainable production, stronger supply chains and new value for people and forests

1

Maintain and expand access to the EU market

Deforestation-free and legally produced commodities can retain and grow access to a large, high-value market.



2

Investment in digital agriculture

Accelerates the use of geospatial mapping, satellite monitoring and digital traceability across supply chains.



3

Modernisation of supply chains

Incentivises national farm registries, better land-use maps and interoperable traceability systems.



4

Competitive advantage for African producers

Early adoption can differentiate African commodities, attract premium markets and strengthen brand reputation.



5

Catalyst for sustainable production and greater resilience

With finance, technical support and the right incentives, EUDR can help protect forests, improve livelihoods and build more resilient food systems.



THE NEW ROLE OF AFRICAN REGULATORS IN PROTECTING MARKET ACCESS



1

MAP & REGISTER PRODUCTION



Establish reliable producer and farm registries with geolocation data.



2

BUILD TRACEABILITY SYSTEMS



Enable commodities to be traced from farm to processor to exporter.



3

VERIFY DEFORESTATION-FREE PRODUCTION



Use satellite and national forest data to confirm production is not linked to deforestation.



4

SUPPORT SMALLHOLDERS



Provide training, digital tools and technical support to help smallholders comply and remain in global supply chains.



5

PROVIDE TRUSTED NATIONAL ASSURANCE AND COORDINATION



Coordinate across agriculture, forestry, land, customs and trade authorities to ensure credible, consistent information for export markets.



How **AFRAF** can help Africa meet EUDR requirements and create opportunities

STRONGER REGULATION | SUSTAINABLE FOOD SYSTEMS | GREATER MARKET ACCESS

1 Shape a common African approach to EUDR



Coordinate guidance on geolocation, traceability, legality evidence and verification, reducing duplication and ensuring consistent national approaches.

2 Build shared digital traceability and data standards



Develop and share mapping tools, satellite monitoring, traceability platforms and common data standards, leveraging successful national examples across

3 Protect smallholders and support inclusion



Support farm mapping, training and access to digital tools so smaller producers can meet EUDR requirements and benefit from new market opportunities.

4 Provide a unified African voice



Engage collectively with the EU, share implementation experiences, flag challenges early and help develop practical, Africa-relevant solutions.

Analytical methods to trace the origins of food

1 Stable isotope analysis (IRMS)



Geographic and environmental signatures

2 Elemental fingerprinting (ICP-MS / XRF)



Trace element profiles

3 Spectroscopic methods (NIR / FTIR / Raman)



Molecular fingerprints

4 DNA analysis



Species, variety and population origin

5 NMR spectroscopy



Chemical fingerprints

7 Proteomics



Protein and peptide signatures

6 LC-MS / GC-MS metabolomics



Metabolic and volatile profiles

8 Radiogenic isotopes (e.g. $^{87}\text{Sr}/^{86}\text{Sr}$)



Geological signatures



Combine multiple analytical fingerprints



Data analysis and machine learning



Predict geographical origin

Determining the **country of origin** of soya using ICP-MS

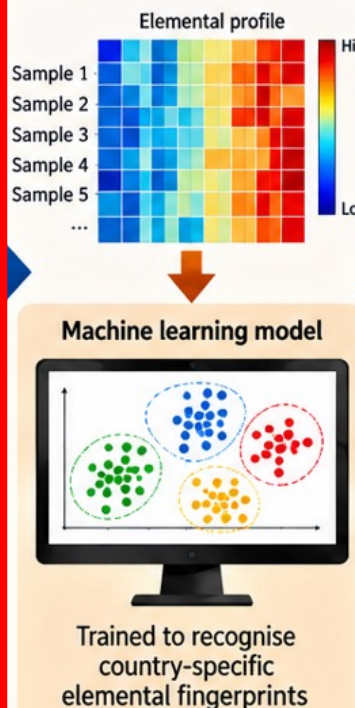
1 Soya samples from different countries



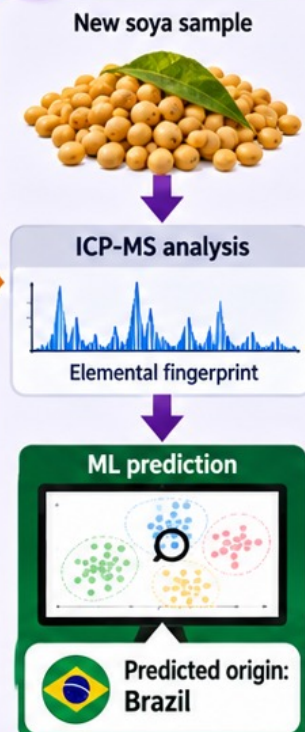
2 Elemental analysis by ICP-MS



3 Data analysis using machine learning



4 Classify unknown samples



5 High accuracy country of origin classification



A Bigger Challenge: Moving from Country of Origin to Region of Origin

Combining spectroscopy and **ICP-MS** to determine the **region of origin** of Brazilian soya



1 Sample collection

246 soybean samples from 5 major producing states in Brazil



2 Multi-platform analysis

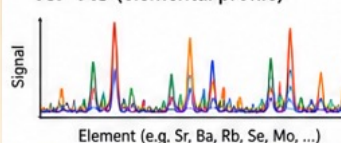
Each sample analysed using complementary techniques



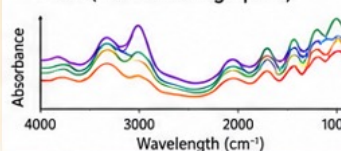
3 Chemical fingerprint

Each technique generates a characteristic fingerprint for the different regions

ICP-MS (elemental profile)



FTIR (molecular fingerprint)

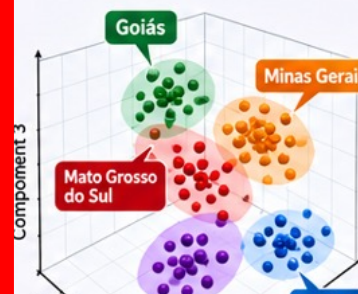


NIR (molecular fingerprint)

4 Data fusion and machine learning

Elemental and spectroscopic data are combined using chemometrics and machine learning to classify samples by state of origin

Fused ICP-MS + FTIR + NIR



5 Predict region of origin

The combined ICP-MS, FTIR and benchtop NIR data gave highly accurate classification of soybeans by Brazilian state

Classification accuracy (3-technique data fusion)

98.6%



The importance of the data fusion approach

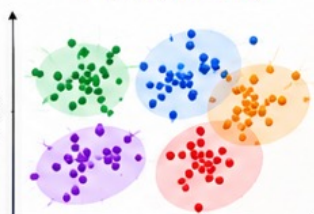


Data fusion refers to any technique that takes multiple sources of data and combines it in some way to either produce a more accurate result, to answer a different or a combination of questions

Data fusion between spectroscopic approaches improves state discrimination

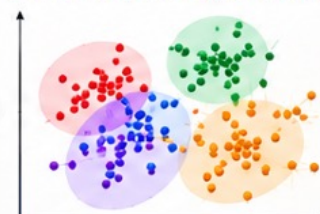
Individual spectroscopic data

FTIR (76.4%)



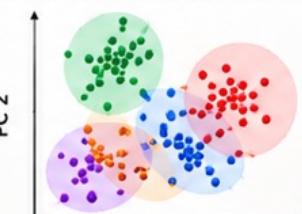
PC 1

Benchtop NIR (76.4%)



PC 1

Portable NIR (66.7%)



PC 1

Spectroscopic fusion (PLS-DA)

FTIR + Benchtop NIR	83.3%
FTIR + Portable NIR	61.1%
Benchtop NIR + Portable NIR	74.3%
FTIR + Benchtop NIR + Portable NIR	80.6%

A staged analytical approach to support **EUDR compliance** for Brazilian soya

Spectroscopy provides a rapid and cost-effective screening tool, with only discrepant samples requiring confirmatory ICP-MS analysis.



1 Sample and document check

Soya consignment with declared state of origin (e.g. Goiás, Paraná, etc.)



2 Rapid spectroscopic screening

FTIR + Benchtop NIR (data fusion)



83.3%
correct classification
by Brazilian state
(PLS-DA)

Advantages

- ✓ Rapid (seconds-minutes)
- ✓ Cost-effective
- ✓ High throughput
- ✓ Non-destructive
- ✓ Suitable for routine screening

3 Compare with declared origin



Spectroscopy result matches documentation

(83.3% expected to be correct)



Spectroscopy result does not match documentation

(16.7% require further testing)



4 Confirmatory testing by ICP-MS



High discriminatory power (98.6% accuracy in study)



Elemental fingerprint confirms state of origin



Used only for discrepant samples ($\approx 16.7\%$)

5 Compliance outcome



Origin confirmed

Supports EUDR due diligence and allows consignment to continue in the supply chain.



Mismatch confirmed

Indicates potential mislabeling or higher risk of non-compliance.

Further investigation and supply chain action required.

A Cost-Effective Workflow to Meet EU Regulations

Estimated sample flow
(using study performance)



83.3%

Classified correctly
by spectroscopy
(no further testing needed)



16.7%

Potential discrepancies
(requires ICP-MS confirmation)

**Efficient, risk-based
approach for EUDR
compliance**

Reduces laboratory
costs and analysis time

Focuses ICP-MS resources
on samples of concern

Maintains high confidence
in geographical origin
declarations

Supports transparent
and deforestation-free
supply chains



Agilent – AFRAF – African Countries

A partnership for a **world-leading EUDR passport scheme**

Data fusion for trusted, deforestation-free African commodities



Agilent



ANALYTICAL TECHNOLOGY & EXPERTISE



AFRAF
African Food Regulatory
Authorities Forum



REGULATORY COORDINATION & CAPACITY BUILDING



**African
Countries**



NATIONAL IMPLEMENTATION & SUPPLY CHAINS



EUDR passport scheme – from sample to market

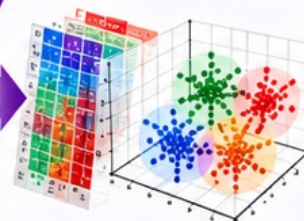
1 SAMPLE & RECORD ORIGIN



2 RAPID SPECTROSCOPIC SCREENING



3 DATA FUSION & CLASSIFICATION



4 EUDR PASSPORT GENERATED



5 TARGETED CONFIRMATION (ICP-MS)



6 DEFORESTATION-FREE MARKET ACCESS

