



International Collaboration of Developing a 2-Tier System (Spectrometry and Spectroscopy) for Tea Authenticity

Di Wu Ph.D.
Newton International Fellow
Queen's University of Belfast



**QUEEN'S
UNIVERSITY
BELFAST**

IGFS THE INSTITUTE
FOR GLOBAL
FOOD SECURITY

Continuing of the EU- China collaborations



The EU-China Safe program finishes here- BUT It's not the end



QUEEN'S
UNIVERSITY
BELFAST

IGFS

THE INSTITUTE
FOR GLOBAL
FOOD SECURITY

Tea or Cha? Tea Trades in the Past



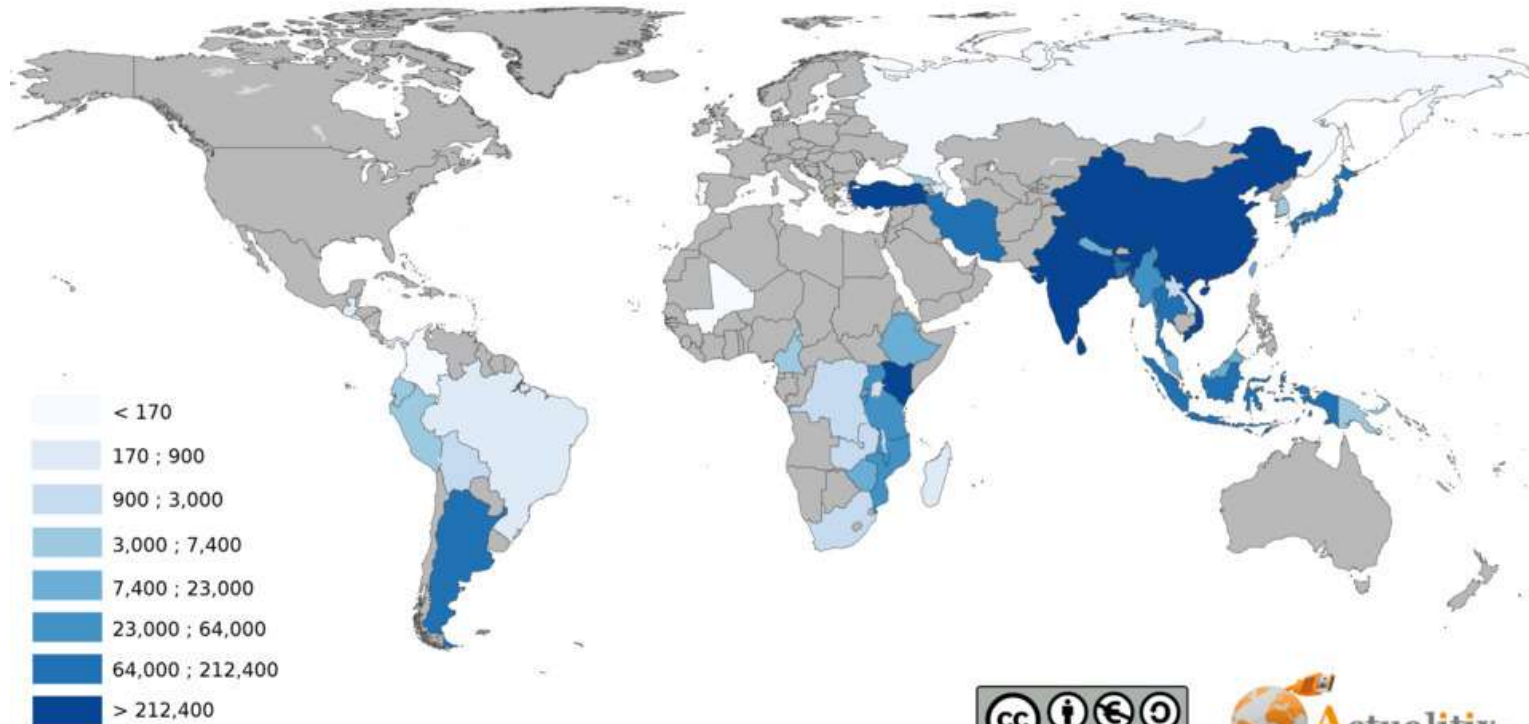
QUEEN'S
UNIVERSITY
BELFAST

IGFS

THE INSTITUTE
FOR GLOBAL
FOOD SECURITY

Global Tea Producing Map

Tea - Production (Tons)



Source : FAO - 2013
Copyright © Actualitix.com All rights reserved



**QUEEN'S
UNIVERSITY
BELFAST**

IGFS

**THE INSTITUTE
FOR GLOBAL
FOOD SECURITY**

Global Tea Consumption Map



**QUEEN'S
UNIVERSITY
BELFAST**

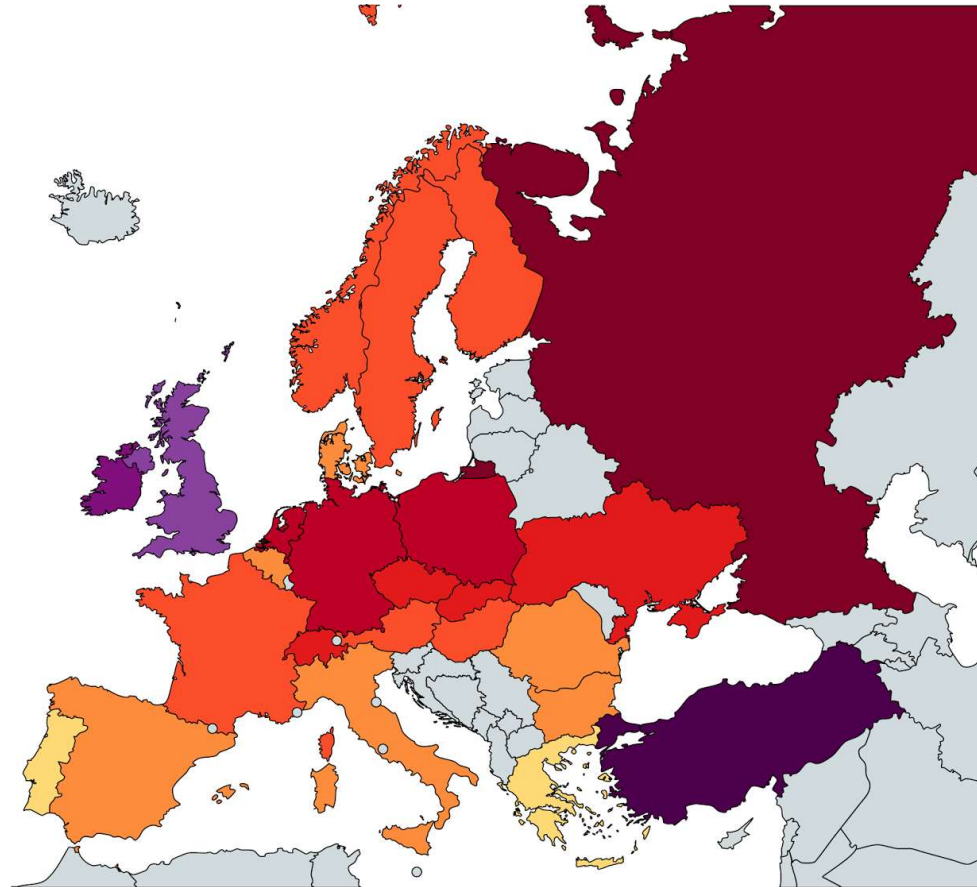
IGFS

**THE INSTITUTE
FOR GLOBAL
FOOD SECURITY**

Tea Consumption Map for Europe

Map of countries by tea consumption per capita(kg)

- Above 3
- Above 2
- 1.5-1.99
- 1-1.49
- 0.6-0.99
- 0.3-0.59
- 0.2-0.29
- 0.1-0.15
- 0.02-0.08



Created with mapchar.net ©



**QUEEN'S
UNIVERSITY
BELFAST**

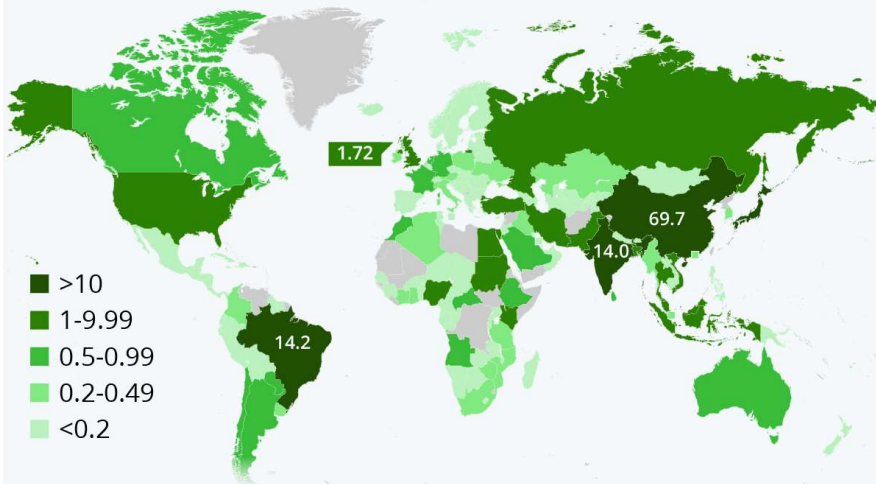
IGFS

**THE INSTITUTE
FOR GLOBAL
FOOD SECURITY**

A Growing Global Tea Market

Where Tea Generates the Most Money

Estimated revenue generated from tea in 2020 (in billion euros)*



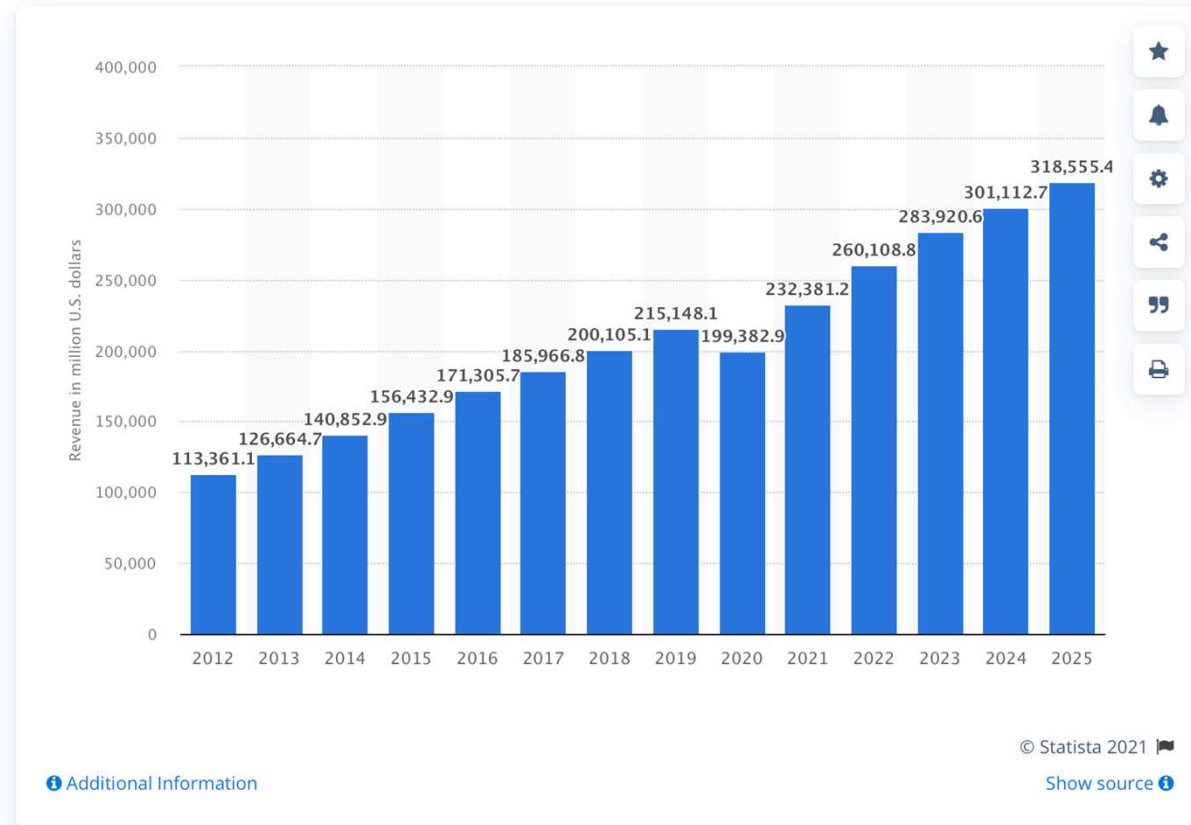
- >10
- 1-9.99
- 0.5-0.99
- 0.2-0.49
- <0.2

* In-scope: Tea bags, loose tea, black tea, green tea, mate.
Source: Statista Consumer Market Outlook



statista

Value of the global tea market from 2012 to 2025
(in million U.S. dollars)



Additional Information

© Statista 2021

Show source

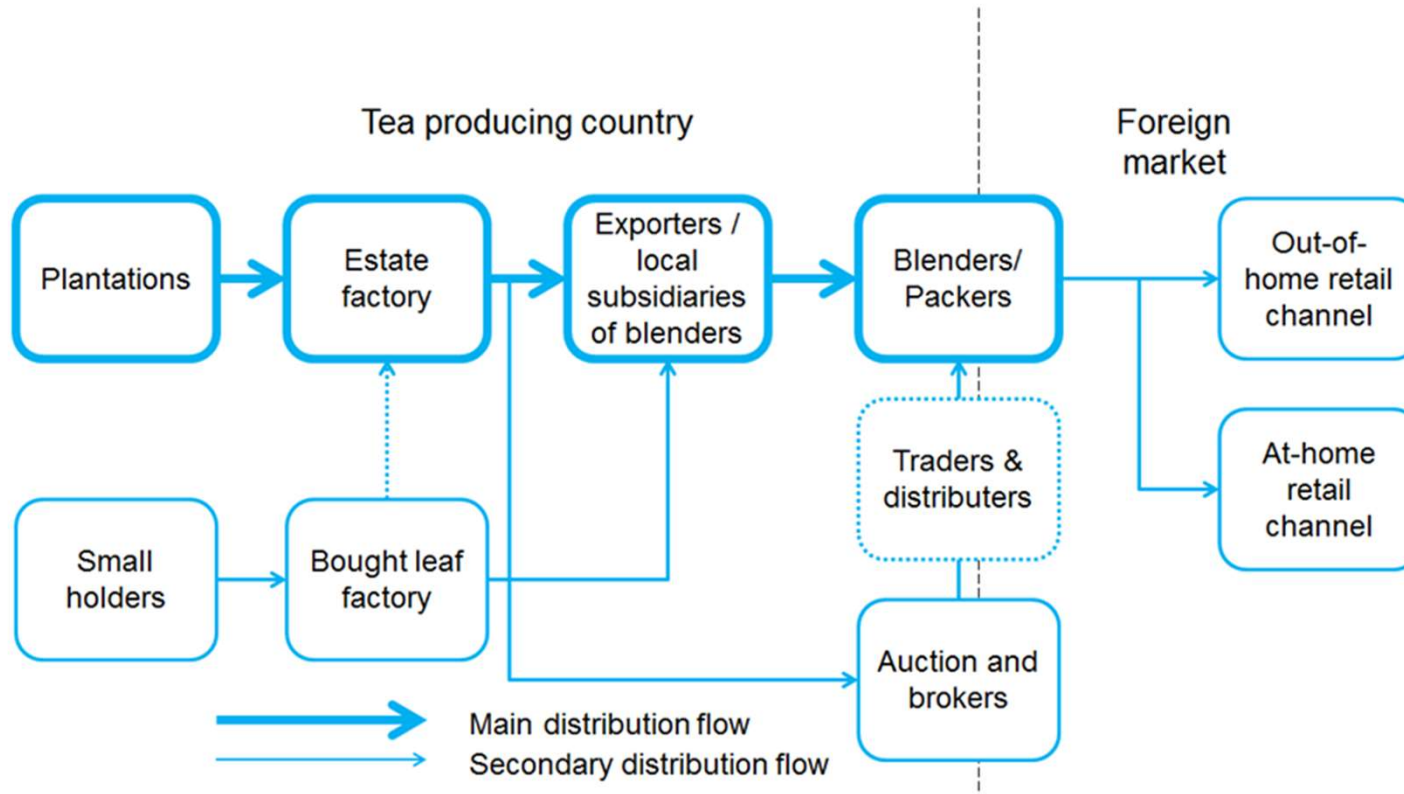


QUEEN'S
UNIVERSITY
BELFAST

IGFS

THE INSTITUTE
FOR GLOBAL
FOOD SECURITY

Supply Chains for European Markets



Different Types of Tea

Chemicals changes during fermentation:
Leading to a change in flavour, colour and health beneficials



Degrees of Fermentation and Oxidation



Different Tea Growing Environments



Longjing- Hangzhou



Kenya



Rock Tea- Wuyi Mountain



QUEEN'S
UNIVERSITY
BELFAST

IGFS

THE INSTITUTE
FOR GLOBAL
FOOD SECURITY

Major Chinese Tea Producing Area



中国茶产区地图

- 华南茶区
- 西南茶区
- 江南茶区
- 江北茶区



QUEEN'S
UNIVERSITY
BELFAST

IGFS

THE INSTITUTE
FOR GLOBAL
FOOD SECURITY

Top 10 Popular Tea in China (2002)

Green Tea:

Long Jing Tea(西湖龙井)

Huangshan Maofeng Tea (黄山毛峰)

Biluochun Tea (碧螺春)

Junshan Yinzhen Tea (君山银针)

Xinyang Maojian Tea (信阳毛尖)

Duyun Maojian Tea (都匀毛尖)

Lu'an Melon Seed (六安瓜片)

Oolong Tea:

Tieguanyin Tea (铁观音)

Wuyi Rock Tea (武夷岩茶)

Black Tea:

Keemun Tea (祁门红茶)



六安瓜片



铁观音



都匀毛尖



祁门红茶



武夷岩茶



黄山毛峰



君山银针



信阳毛尖



西湖龙井



碧螺春

中国十大名茶



QUEEN'S
UNIVERSITY
BELFAST

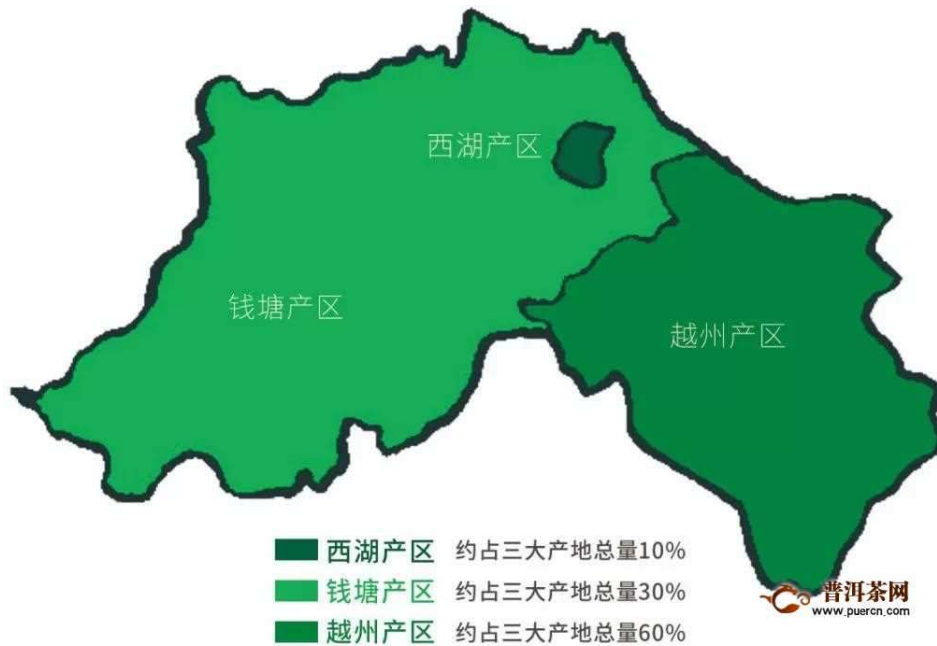
IGFS

THE INSTITUTE
FOR GLOBAL
FOOD SECURITY

Case of Longjing Green Tea

龙井茶产区分布图

GB/T18650-2008 地理标志产品龙井茶



Price Range: Maximum ~1000 folds



QUEEN'S
UNIVERSITY
BELFAST

IGFS

THE INSTITUTE
FOR GLOBAL
FOOD SECURITY

EU and China Sign Landmark Agreement Protecting Geographical Indications in 2020



28 out of first 100 Chinese GI product list, and 31 out of the second 175 list are tea.

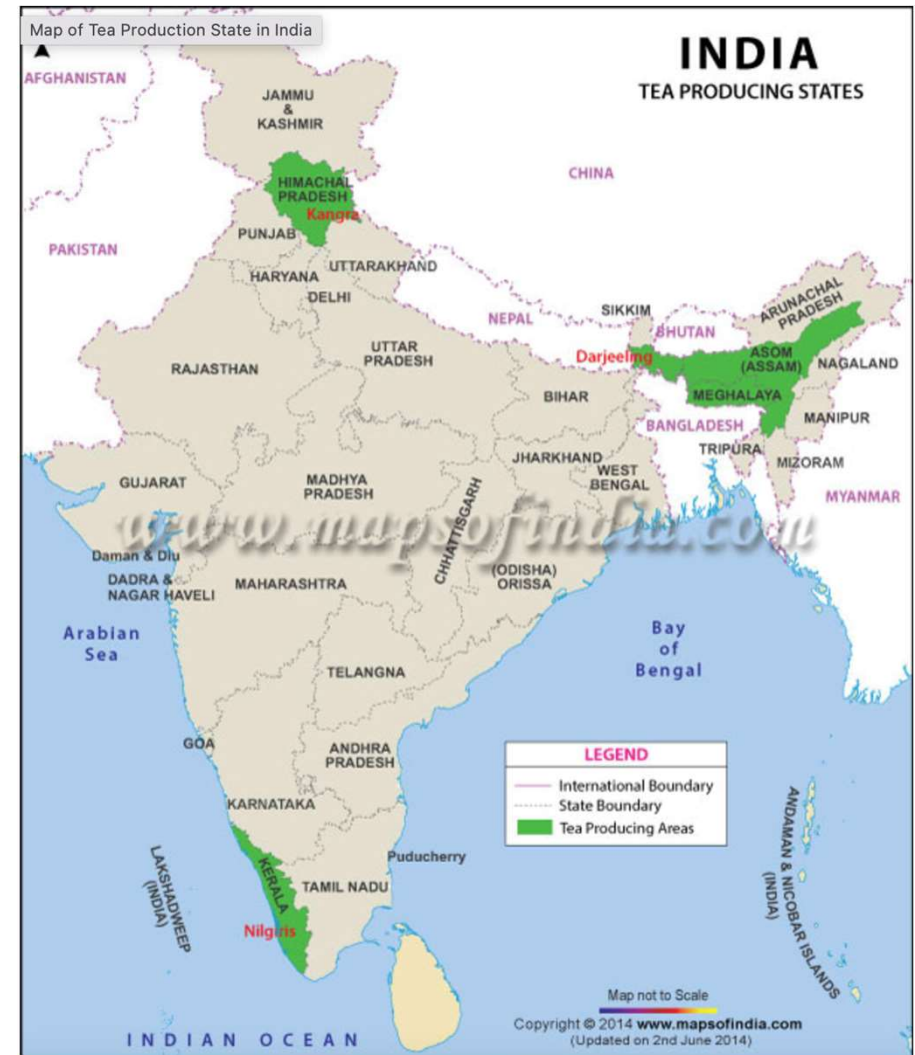


QUEEN'S
UNIVERSITY
BELFAST

IGFS

THE INSTITUTE
FOR GLOBAL
FOOD SECURITY

Indian Tea Producing

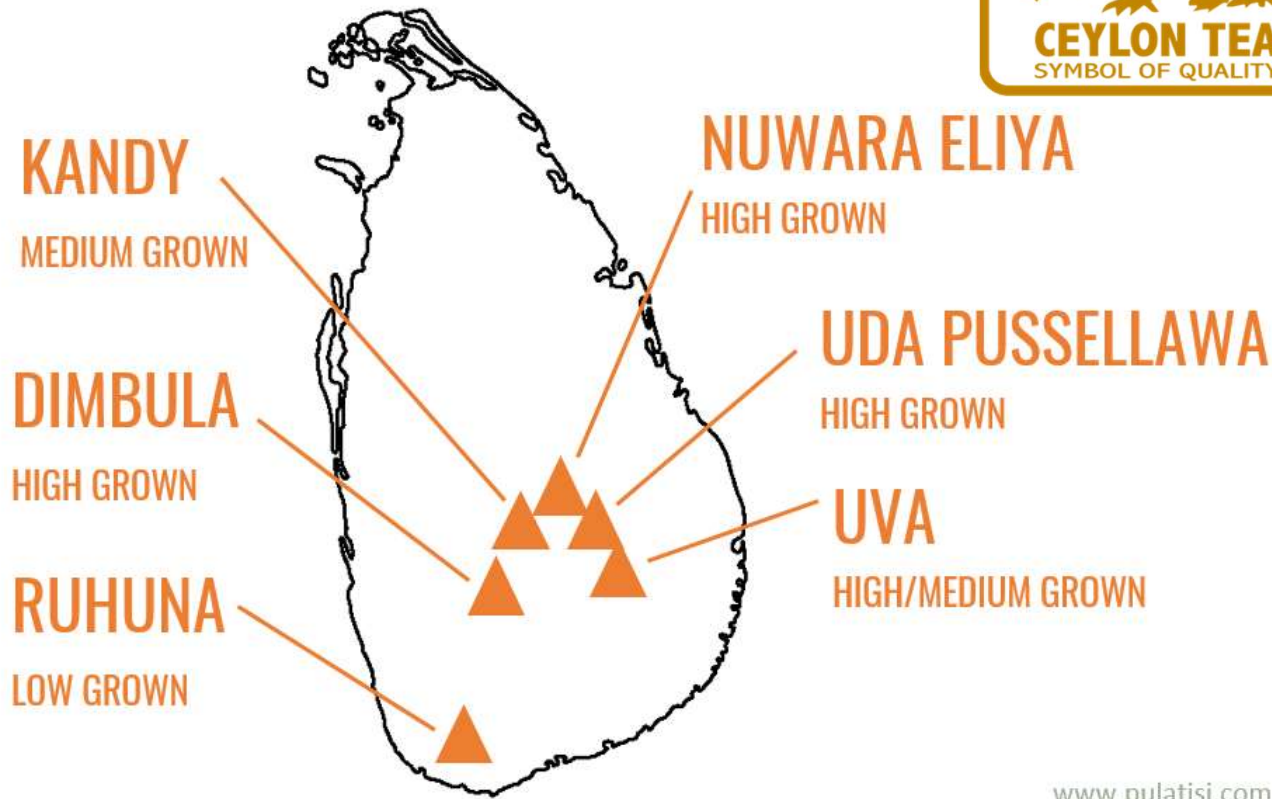


**QUEEN'S
UNIVERSITY
BELFAST**

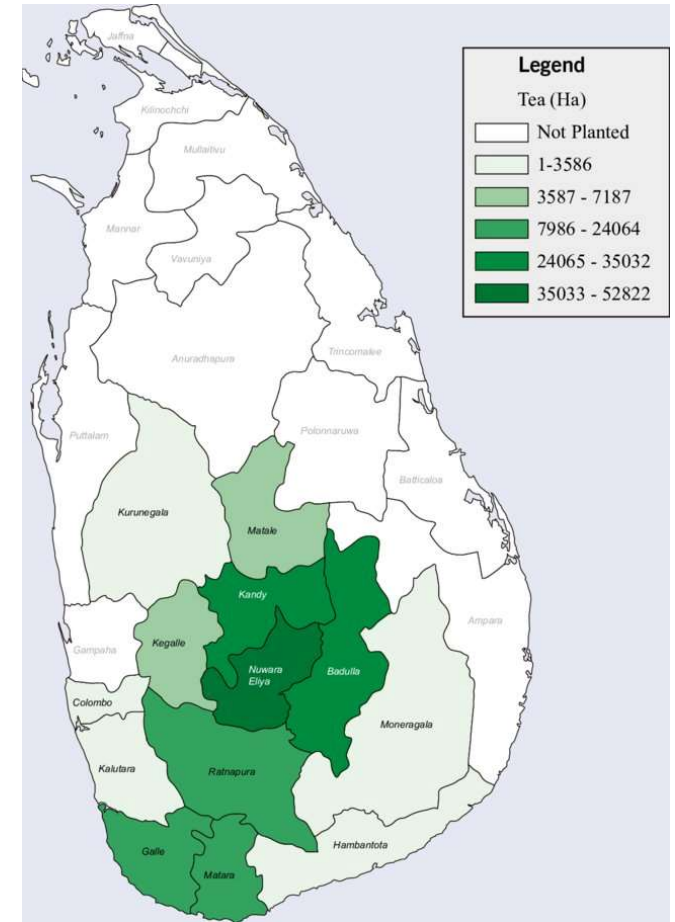
IGFS

**THE INSTITUTE
FOR GLOBAL
FOOD SECURITY**

Tea Producing in Sri Lanka



www.pulatasi.com

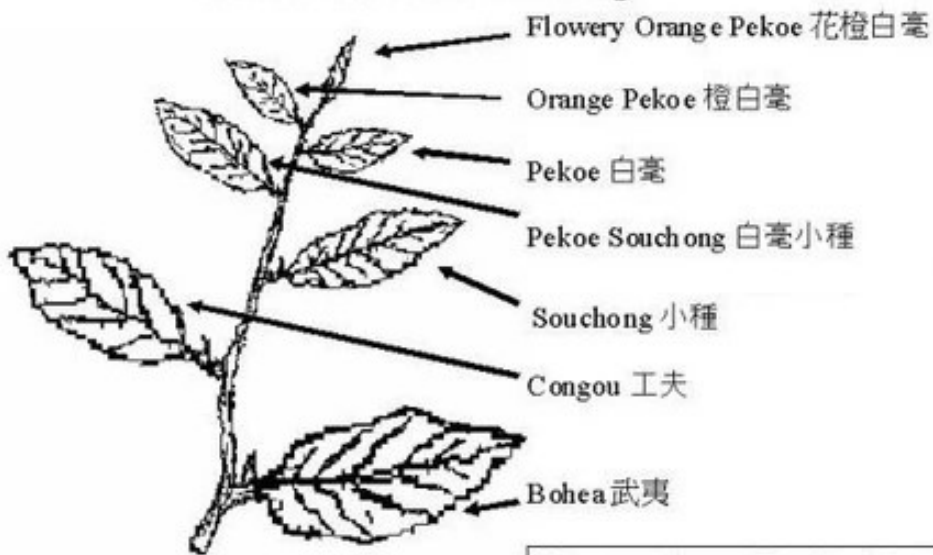


**QUEEN'S
UNIVERSITY
BELFAST**

IGFS THE INSTITUTE
FOR GLOBAL
FOOD SECURITY

Indian Black Tea Classification Systems

Black Tea Leaf Grading *



*Note: only used for black tea, in India and nearby.



Steven R. Jones 7/10/2009



QUEEN'S
UNIVERSITY
BELFAST

IGFS

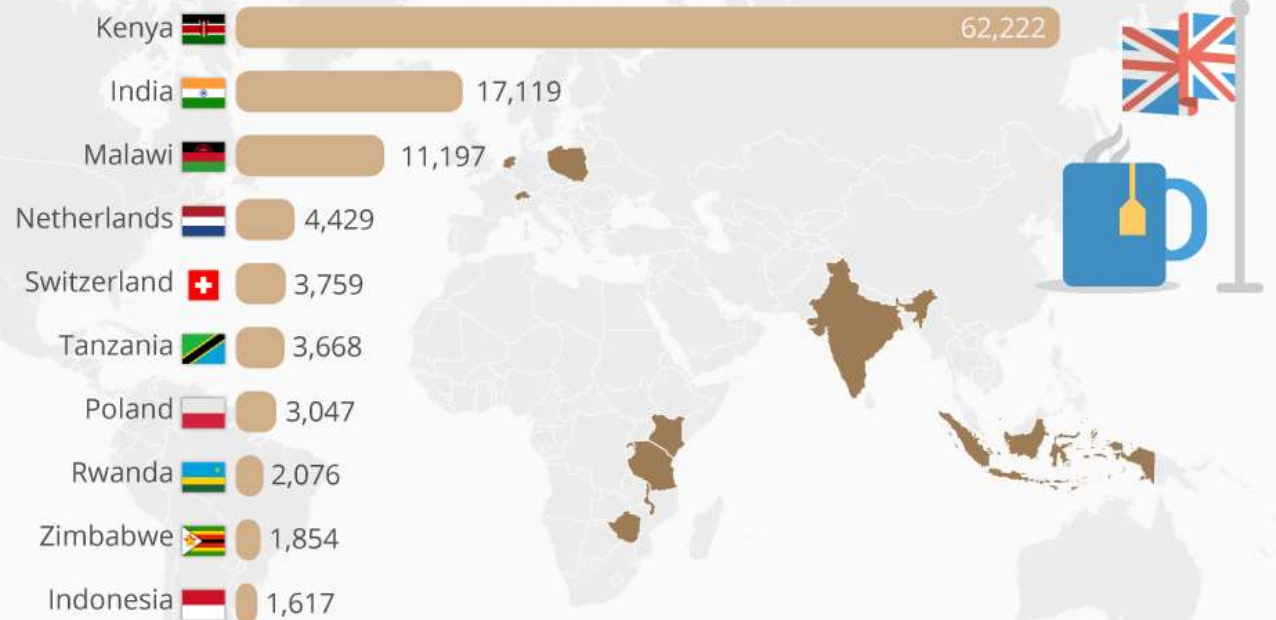
THE INSTITUTE
FOR GLOBAL
FOOD SECURITY

U.K.'s Tea Import

A growing trend in cheaper tea sourcing from African countries

Where does the UK's tea come from?

Countries from which the UK imported the most black tea in 2017 (in tons)



Combined figures for black fermented tea in immediate packings of 'less than 3kg' and 'more than 3kg'.
Source: International Trade Centre/TradeMap

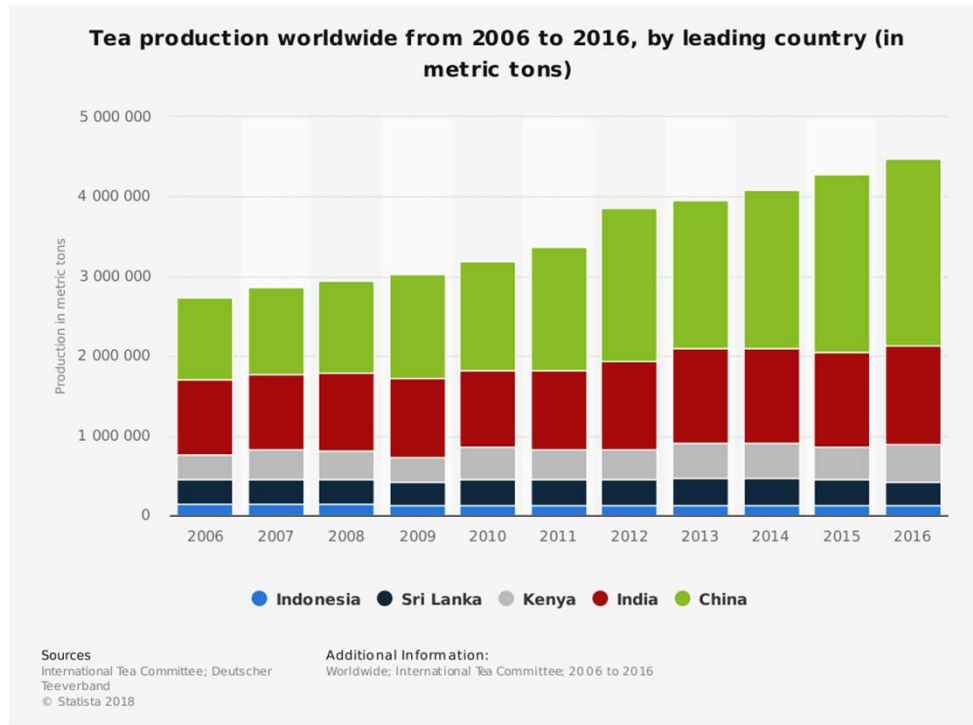


QUEEN'S
UNIVERSITY
BELFAST

IGFS

THE INSTITUTE
FOR GLOBAL
FOOD SECURITY

Tea Production in African Countries



Labor intensive production activity

**A livelihood for the poor:
Worker welfare**

**Sustainability:
Climate change
Deforesting**

In Kenya, the tea industry is generating about 26% of the total export earnings and about 4% GDP. With more than 80,000 people working on the estate and about 3 million people earning their livelihood from the sector.



**QUEEN'S
UNIVERSITY
BELFAST**

IGFS

**THE INSTITUTE
FOR GLOBAL
FOOD SECURITY**

Price Factors for Tea

Chinese Tea :

Geographic Indications (Especially products from central core area)

Timing of the harvest for green tea: Before Qingming Festival and Guyu (6th solar term)- Freshness

Vintage and storage after fermentation: For some specific black tea varieties like Pu'er Tea

India and Sri-Lanka Tea (Mostly black tea):

GI (Assam, Darjeeling)

Elevation (Low, Medium, High)

Classes of the Tea (Which part of the plant leaf was harvested)

Tea for other countries:

What's being labeled on the product

Have no idea where their tea are coming from and it's quality



**QUEEN'S
UNIVERSITY
BELFAST**

IGFS THE INSTITUTE
FOR GLOBAL
FOOD SECURITY

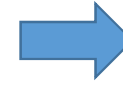
Identifying Fraud in Tea- Is Your Tea Really Tea?



Rice Husks



Caffeine +Dye+ Flavors



Spent Tea



Graphite



Dye(Inigo Blue)



**QUEEN'S
UNIVERSITY
BELFAST**

IGFS

**THE INSTITUTE
FOR GLOBAL
FOOD SECURITY**

Chinese Food Standards for Catechin and Caffeine

Catechin Equal to tea

GB/T 21733—2008

饮料的茶多酚含量 (mg/kg)

茶多酚含量	500mL 含茶叶 (g)
234.05	0.59
253.49	0.63
282.06	0.71
364.40	0.91
436.03	1.09
444.56	1.11
457.86	1.14
472.14	1.18
533.65	1.33

Conventional tea drink products on Chinese markets from a research run by Jinghua Times in 2012

Average Tea bags: ~ 2g
Potted Tea: 5-20 g for 250- 500 mL

表 1 理化指标

项 目	茶饮料 (茶汤)	调味茶饮料					复(混)合茶饮料
		果汁	果味	奶	奶味	碳酸	
茶多酚/(mg/kg) ≥	红茶	300	200	200	100	150	150
	绿茶	500					
	乌龙茶	400					
	花茶	300					
	其他茶	300					
咖啡因/(mg/kg) ≥	红茶	40	35	35	20	25	25
	绿茶	60					
	乌龙茶	50					
	花茶	40					
	其他茶	40					
果汁含量 (质量分数)/%		≥5.0					
蛋白质含量 (质量分数)/%				≥0.5			
二氧化碳气体含量 (20℃容积倍数)					≥1.5		

注：如果产品声称低咖啡因应按 5.3.4 执行。



QUEEN'S UNIVERSITY BELFAST

IGFS

THE INSTITUTE FOR GLOBAL FOOD SECURITY

Time to Get on Board

Researchers

Students

Food Agencies



Retailors

Industry Partners

Other Stakeholders

Together We Make Miracles



QUEEN'S
UNIVERSITY
BELFAST

IGFS

THE INSTITUTE
FOR GLOBAL
FOOD SECURITY

Connections and Engagements Made Amongst Stakeholders for Tea



国家食品安全风险评估中心
China National Center for Food Safety Risk Assessment



QUEEN'S
UNIVERSITY
BELFAST

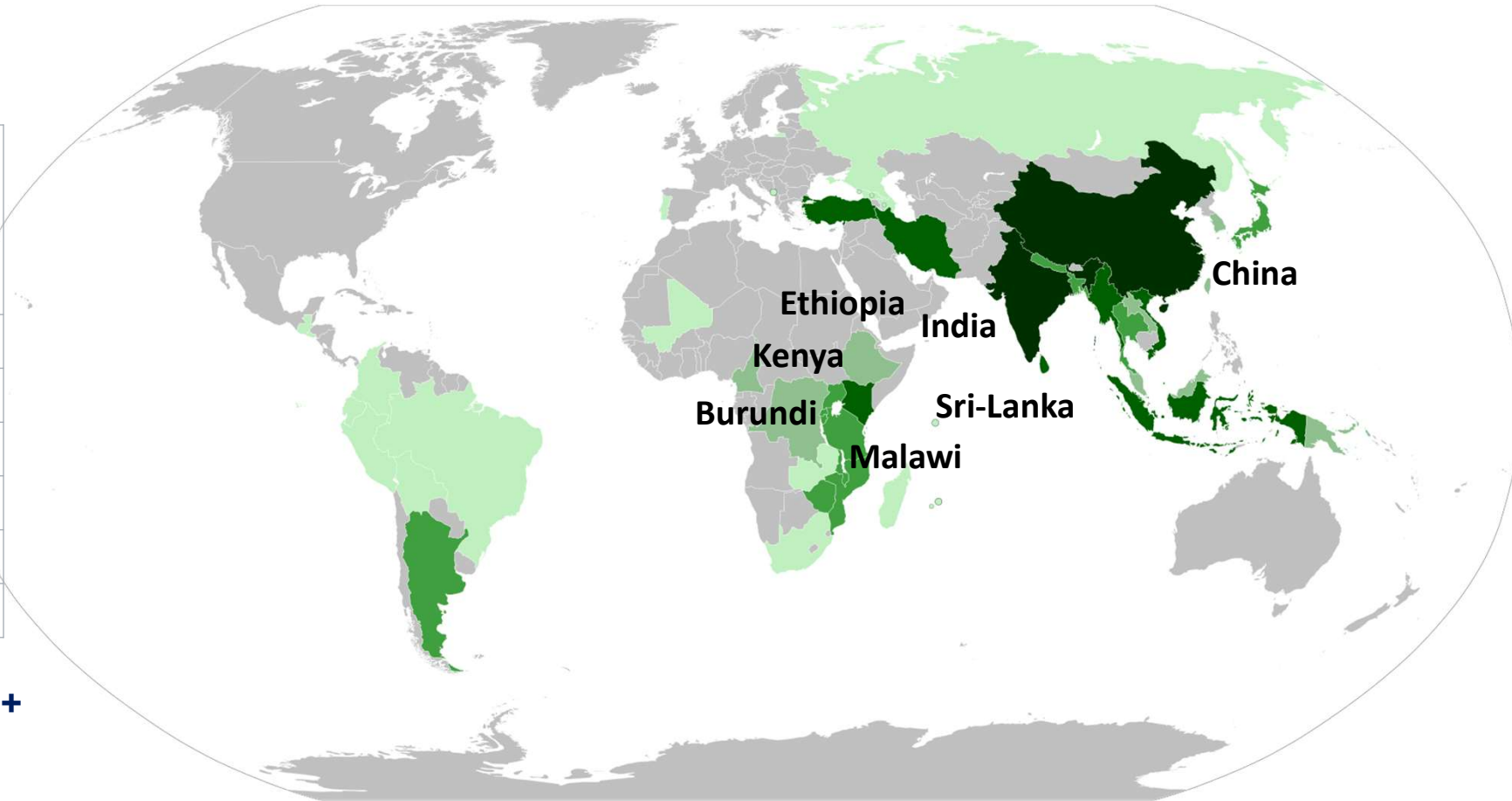
IGFS

THE INSTITUTE
FOR GLOBAL
FOOD SECURITY

Tea Samples Received from Different Origins

Country	Sample
China	82+50
Kenya	41+40
Ethiopia	40
Burundi	40
Malawi	40
India	40

Sri-Lanka: Around 400+
under collection

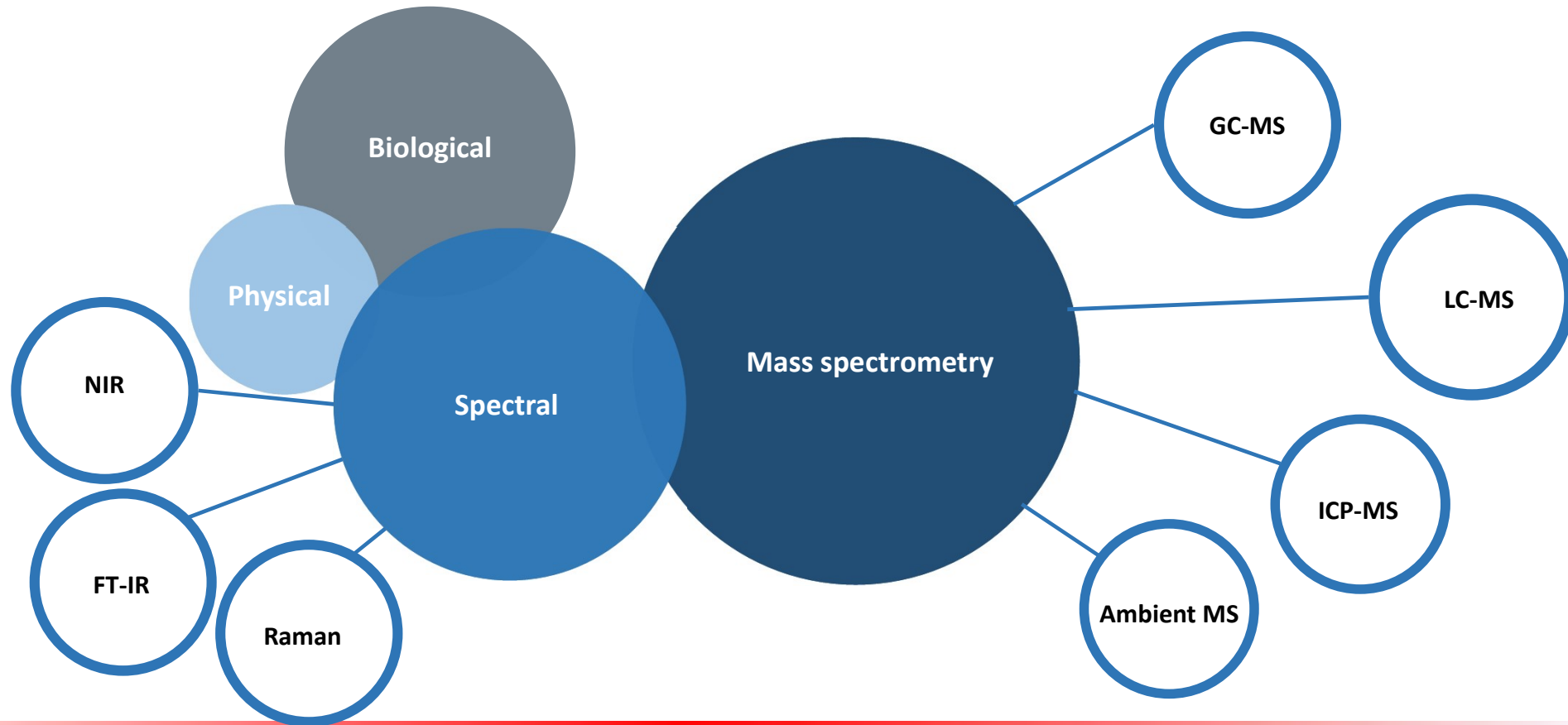


QUEEN'S
UNIVERSITY
BELFAST

IGFS

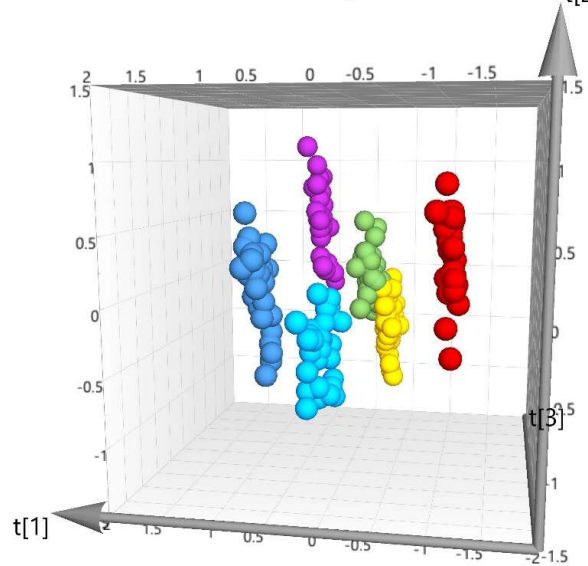
THE INSTITUTE
FOR GLOBAL
FOOD SECURITY

The Two-Tier Analytical Platform of IGFS



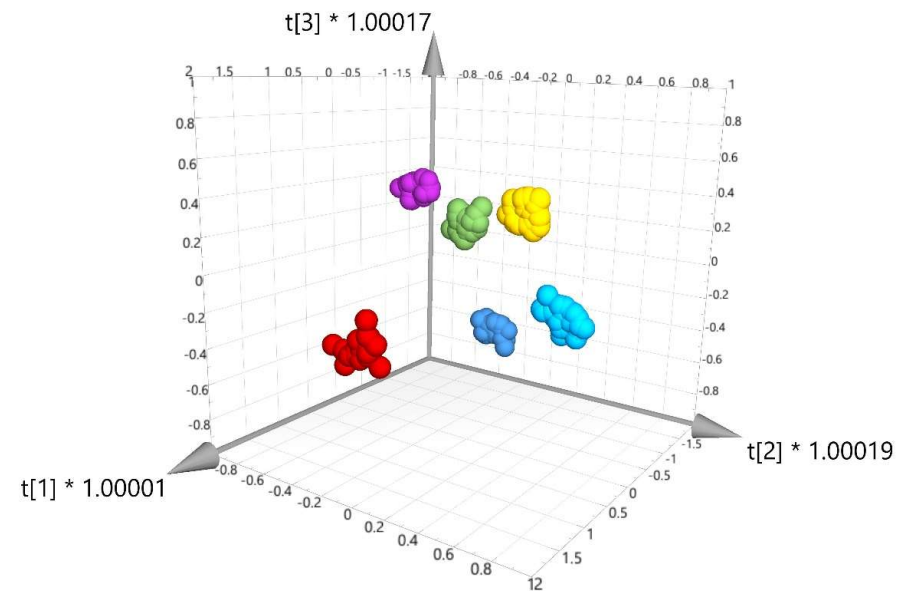
Tea models with FT-IR of Black Tea Samples

Tea FT-IR model set (iS50) (M16, PCA-X), SNV-1D-SG_Par_model set
Colored according to classes in M16



- Classes
- Burundi
 - Ethiopian
 - India
 - Kenya
 - Kenya 2
 - Malawian

Tea FT-IR model set (iS50) (M14, OPLS-DA), SNV-1D-SG_Par_model set
Colored according to classes in M14



- Classes
- Burundi
 - Ethiopian
 - India
 - Kenya
 - Kenya 2
 - Malawian

SIMCA 17 - 09/09/2021 16:11:54 (UTC+1)

SIMCA 17 - 09/09/2021 16:18:18 (UTC+1)



QUEEN'S
UNIVERSITY
BELFAST

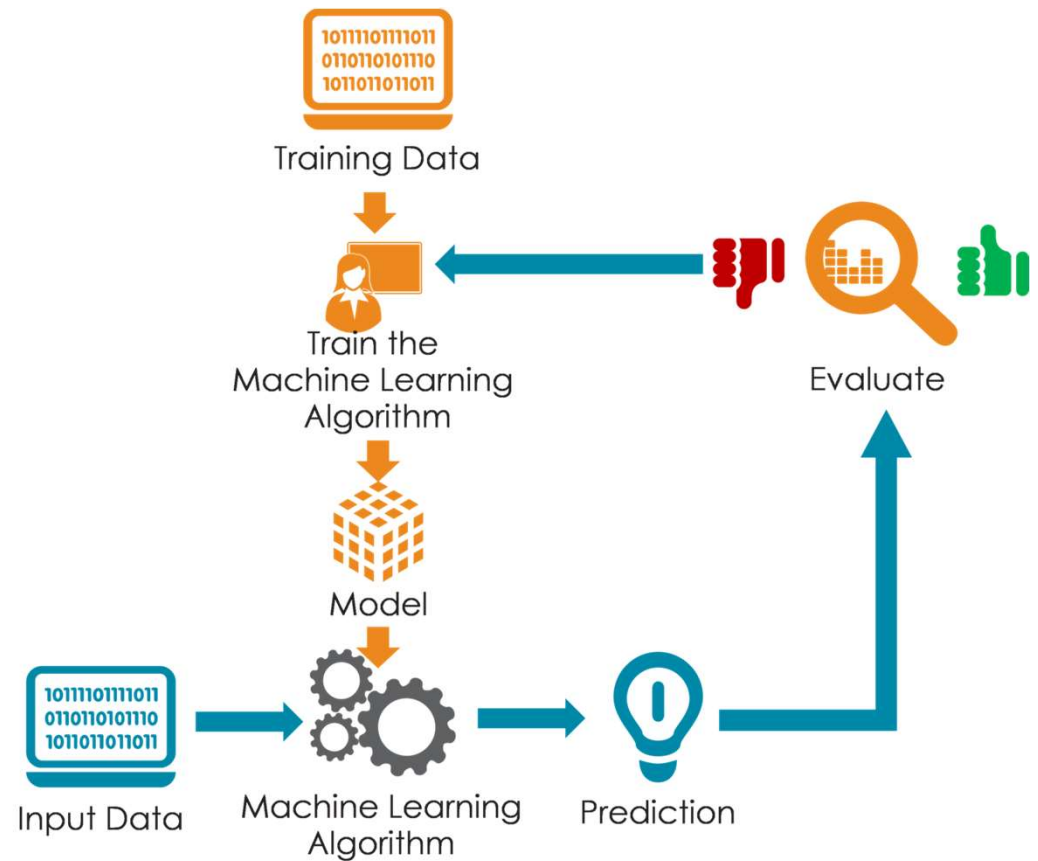
IGFS

THE INSTITUTE
FOR GLOBAL
FOOD SECURITY

AI+ and Machine Learning

Multiple approaches to be explored starting with R-pipeline and Python

Analytical data from different spectroscopy and spectrometry platforms will be used



Approaches for Next Stage

Continue sourcing samples from different origins, especially GI products:

Sri-Lanka

India

Black tea from China

Seeking for new opportunities of collaboration

Identifying new types of potential adulterations in tea industry

Fingerprinting and chemometric modeling:

ICP-MS

Ambient-MS: REIMS

LC-QToF

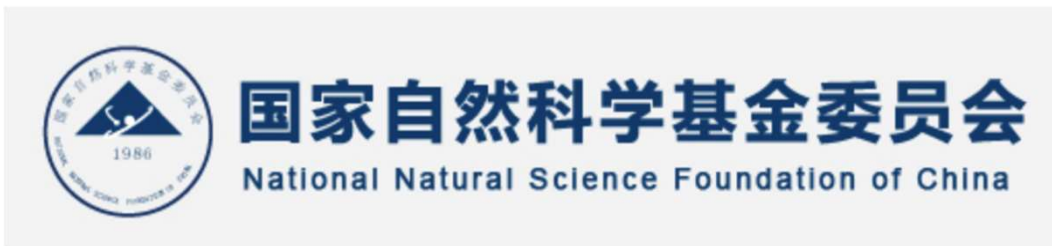
GC-MS



QUEEN'S
UNIVERSITY
BELFAST

IGFS THE INSTITUTE
FOR GLOBAL
FOOD SECURITY

Acknowledgement



QUEEN'S
UNIVERSITY
BELFAST

IGFS THE INSTITUTE
FOR GLOBAL
FOOD SECURITY

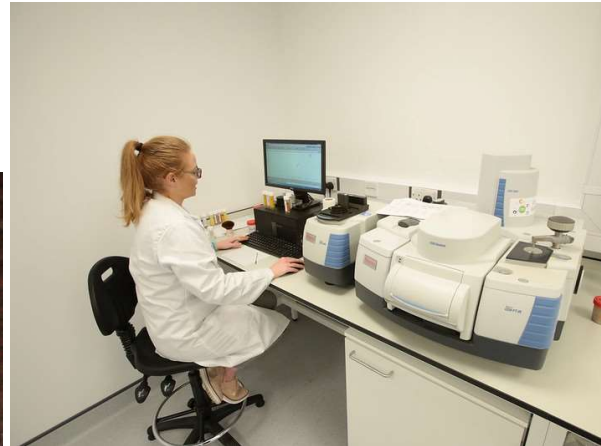
Acknowledgement



QUEEN'S
UNIVERSITY
BELFAST

IGFS THE INSTITUTE
FOR GLOBAL
FOOD SECURITY

Join Us in IGFS ASSET Center



We welcome students, post doctors and all stakeholders in academic and food industry to join our global network of IGFS

chris.elliott@qub.ac.uk

Contact in Chinese: d.wu@qub.ac.uk



**QUEEN'S
UNIVERSITY
BELFAST**

IGFS THE INSTITUTE
FOR GLOBAL
FOOD SECURITY

厚德載物

清華大學金德年書

善至於止

曾國藩

自強不息



QUEEN'S
UNIVERSITY
BELFAST

IGFS

THE INSTITUTE
FOR GLOBAL
FOOD SECURITY