# 21st Century Nuclear Techniques and Research for Food Safety, Food provenance and Agriculture

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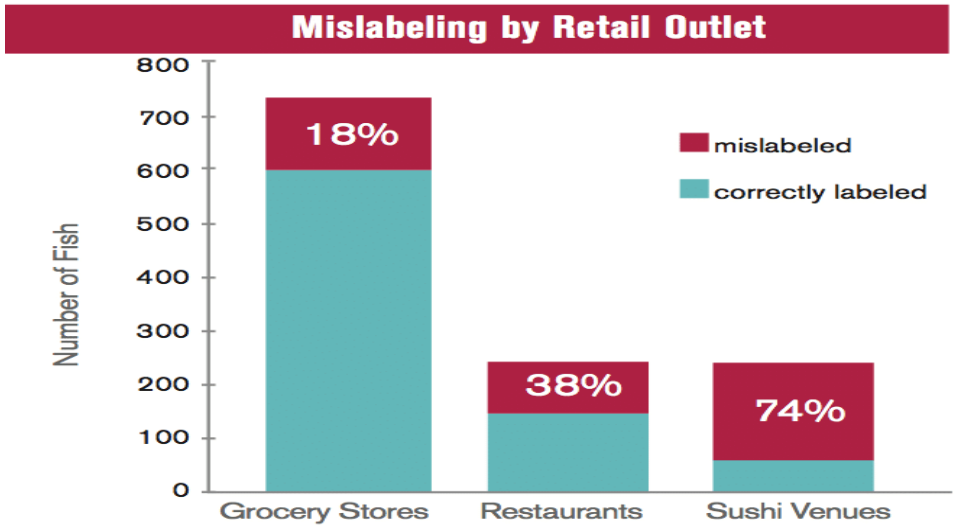
Australian Government

ANSTO

# Background

- Food fraud costs the global food industry $52 billion per year [Price Waterhouse Coopers]
- One in five species of seafood tested in the USA were mislabelled [OCEANA]
- Seafood is the most confiscated food product in the world [INTERPOL]

# Combating Food Fraud

Food Fraud

Food Safety

Mislabelled

Food quality

Hazardous materials

Economy

Public Health

Terror/Bio-security





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# Techniques currently used

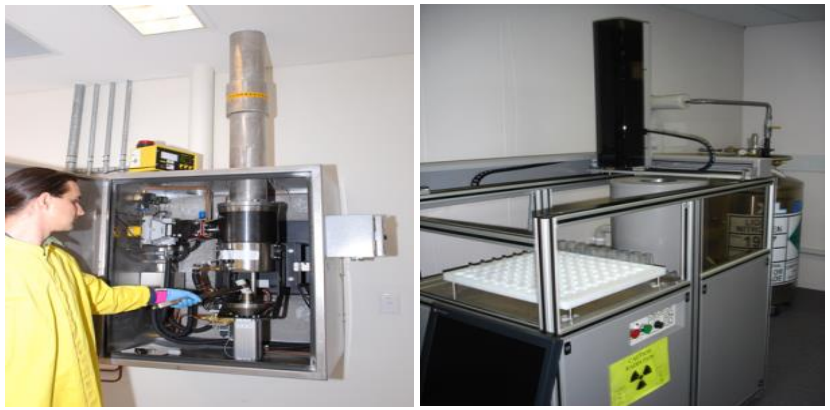
- DNA profiling
- Protein extraction
- Fatty acids
- Blockchain Electronic tagging
  **Elemental and isotopic analysis (ANSTO)**


Gopi, K., **Mazumder, D**., Sammut, J., & Saintilan, N. (2019). Determining the provenance and authenticity of seafood: A review of current methodologies**.** *Trends in Food Science & Technology, 91*, 294-304.


X-ray fluorescence using ITRAX

Food quality analysis at NMI

2 MegaVolt STAR Accelerator for Ion Beam Analysis (IBA)



Neutron Activation Analysis (NAA)

## Isotopic and elemental fingerprinting analysis at ANSTO

Australian Government
Department of Industry, Innovation and Science

National Measurement Institute

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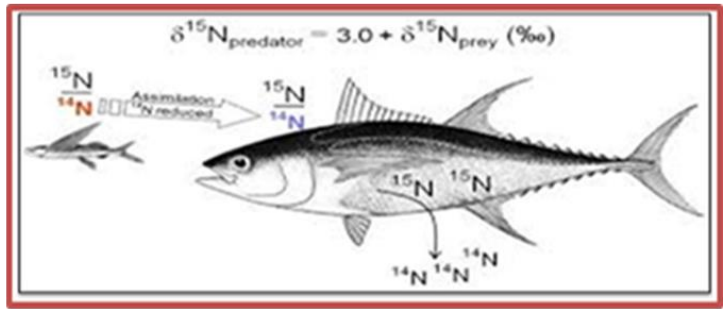
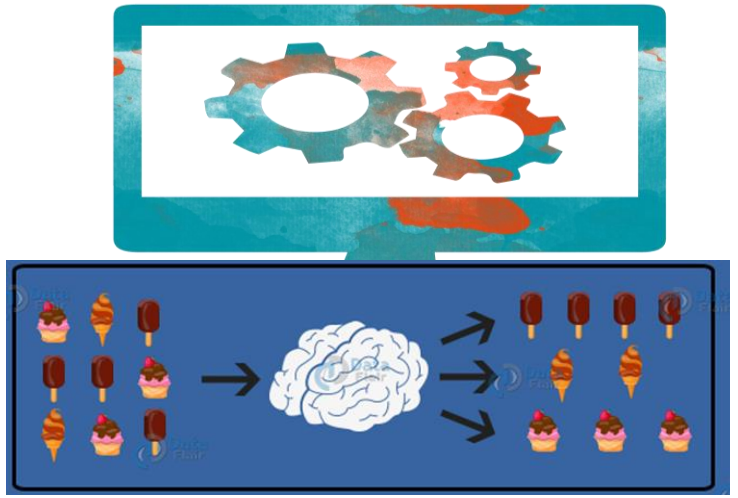
# Fingerprinting technology to determine source and origin of the food

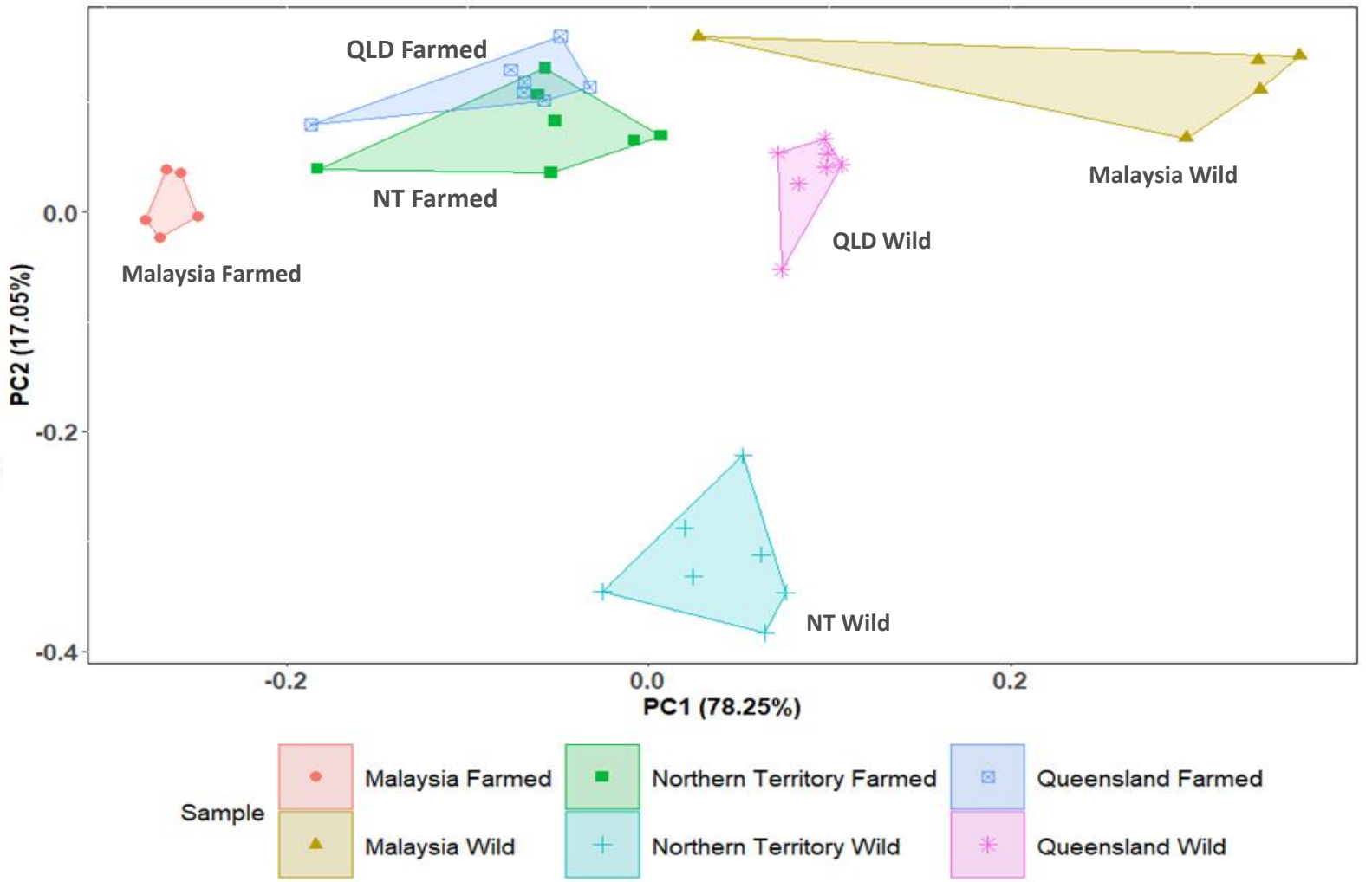


Data input Analyse Find patterns

**Prediction**

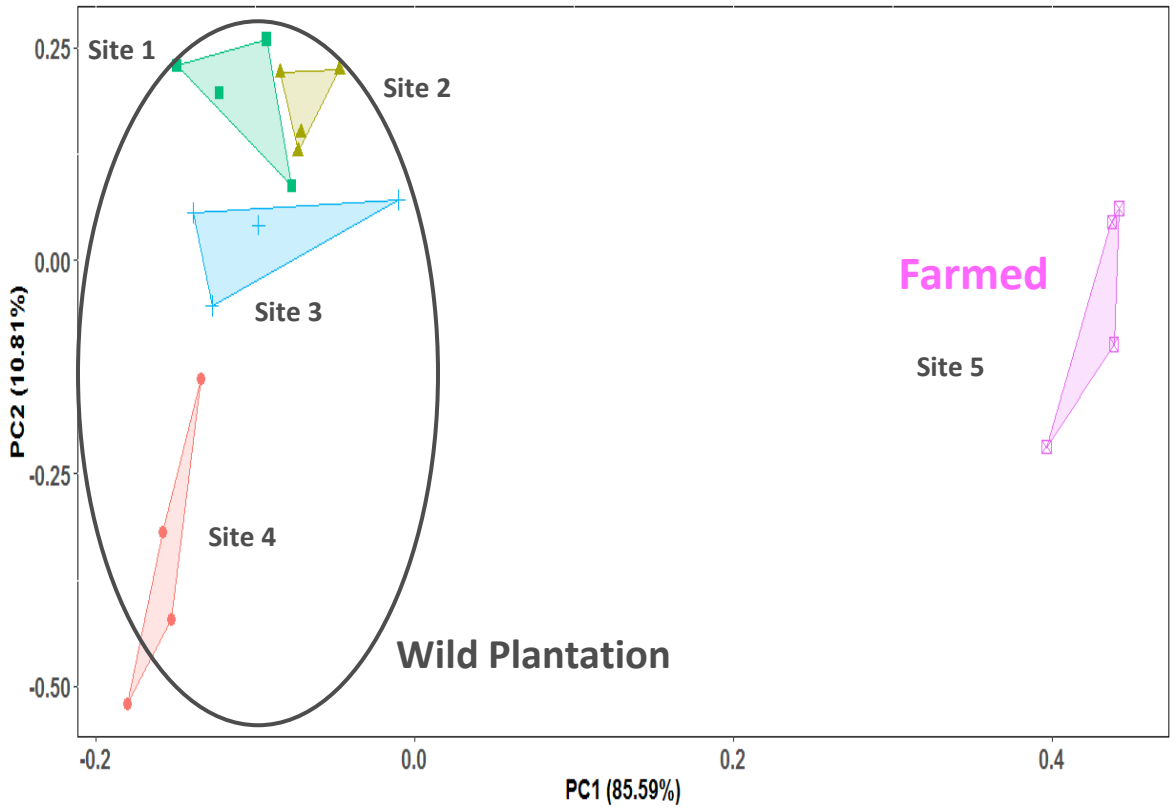
Source of origin and Quality

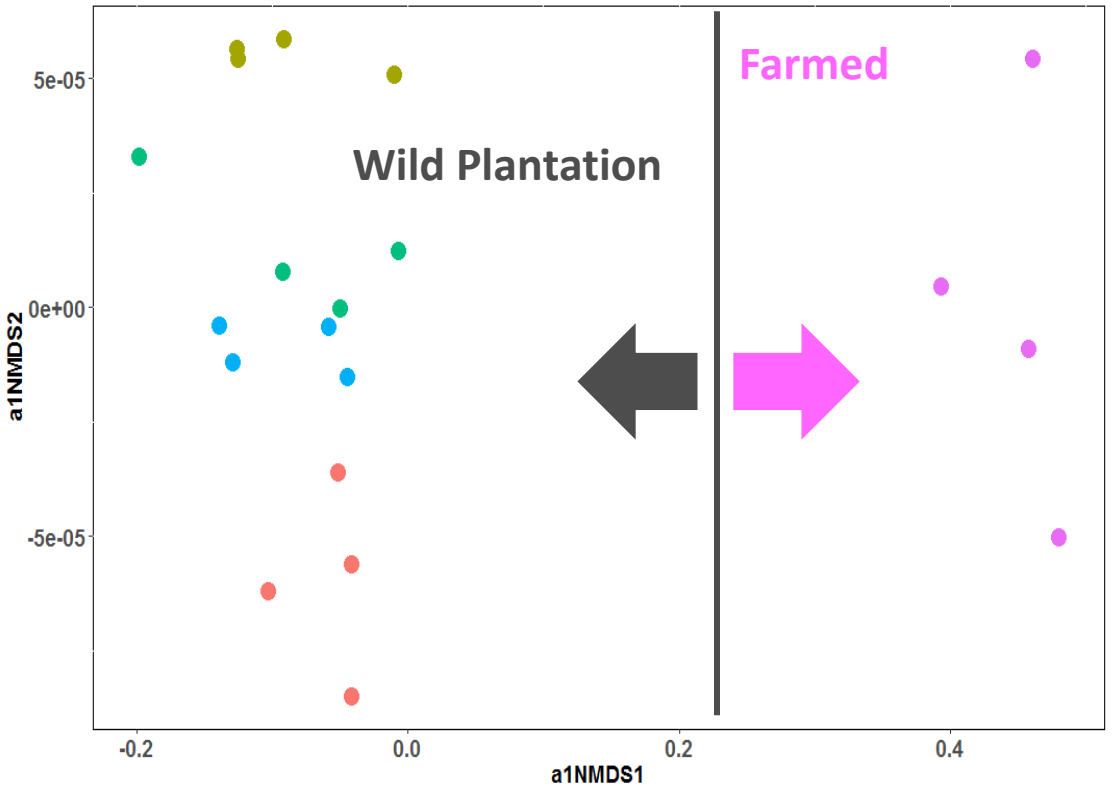

QLD Farmed
NT Farmed
Malaysia Farmed
Malaysia Wild
QLD Wild
NT Wild
0.0
-0.2
-0.4
PC2 (17.05%)
-0.2
0.0
0.2
PC1 (78.25%)
Sample
Malaysia Farmed
Malaysia Wild
Northern Territory Farmed
Northern Territory Wild
Queensland Farmed
Queensland Wild

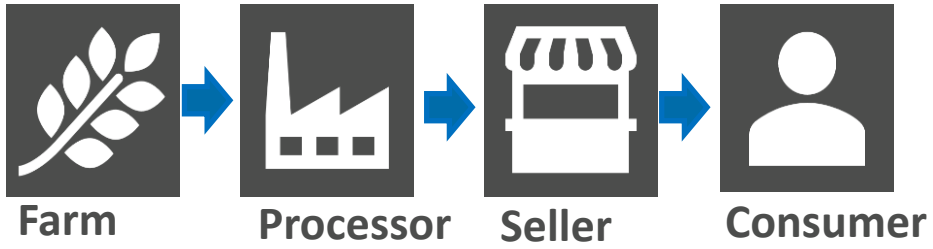
# Model testing

| Results based on SIA and Itrax data combined | | | |
|---|---|---|---|
| | | **Source of origin** | |
| Sample | Source (assumed by Erik) | Australian | Overseas |
| Sample 1 (ANSTO code J1) | North QLD | Data not available | |
| Sample 2 (ANSTO code J3) | QLD | **Australian confirmed (97%).** Also, both elements and isotope fingerprints matching 100% with Queensland farmed prawn. | |
| Sample 3 (ANSTO code J5) | Unknown | | About 66% possibility |
| Sample 4 (ANSTO code J7) | Unknown | | About 85% possibility |
| Sample 5 (ANSTO Code J9) | Unknown | | About 71% possibility |
| Sample 6 (ANSTO code J11) | Unknown | About 59% possibility | |

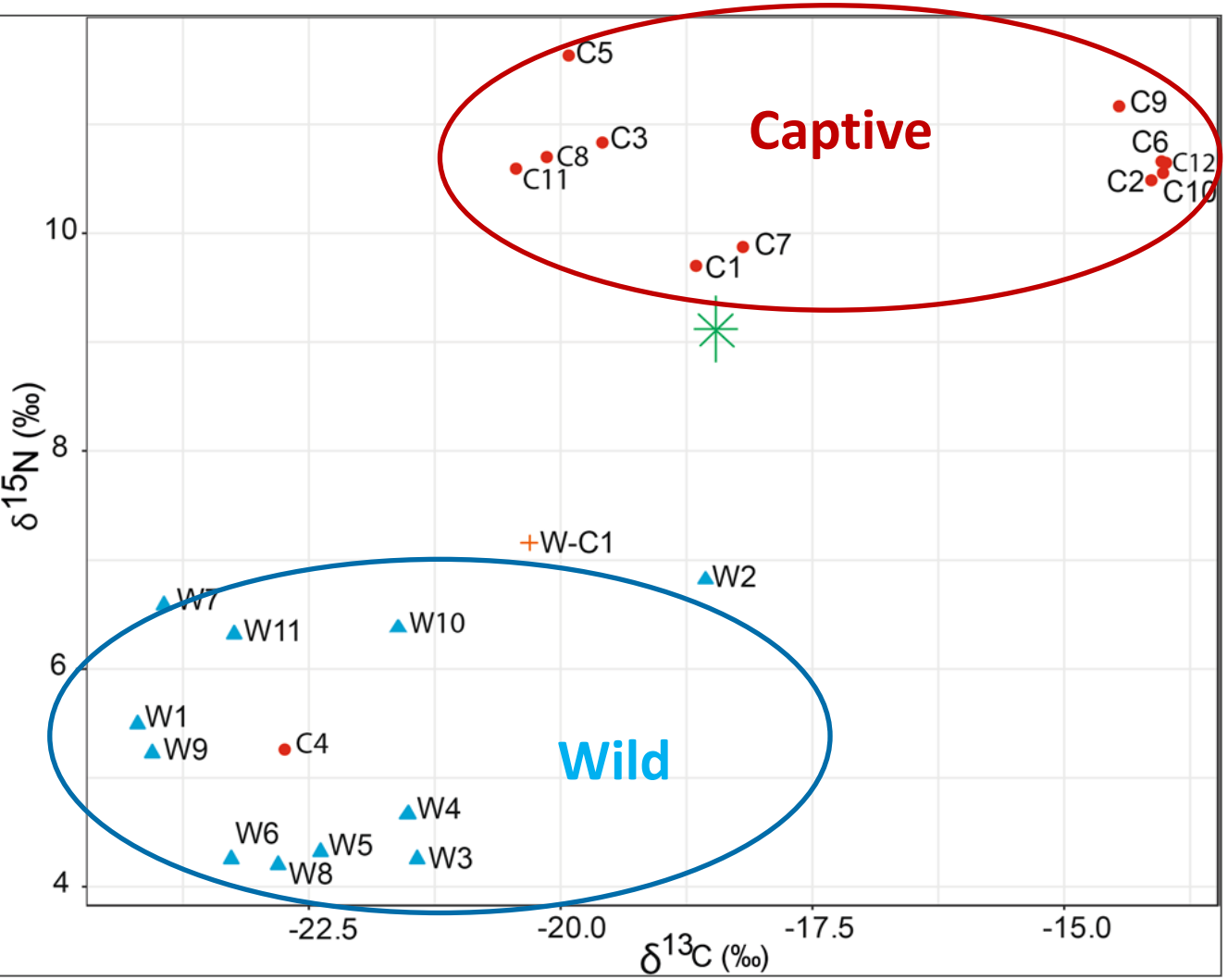
# Case study 2: Market chain traceability and provenance



# Case study-3: Stop illegal trade of endangered animals




SCIENTIFIC REPORTS

OPEN

## Novel detection of provenance in the illegal wildlife trade using elemental data

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Published online: 18 October 2018

Kate J. Brandis[1], Phoebe J. B. Meagher[2], Lydia J. Tong[2], Michelle Shaw[2], Debashish Mazumder[3], Patricia Gadd[3] & Daniel Ramp[4]

Despite being the fourth largest criminal market in the world, no forensic tools have been sufficiently developed to accurately determine the legal status of seized animals and their parts. Although legal trading is permissible for farmed or captive-bred animals, many animals are illegally removed from the wild and laundered by masquerading them as captive bred. Here we present high-resolution x-ray fluorescence (XRF) as a non-invasive and cost-effective tool for forensic classification. We tested the efficacy of this technique by using machine learning on a training set of zoo specimens and wild-caught individuals of short-beaked echidnas (*Tachyglossus aculeatus*), a small insectivorous monotreme in Australia. XRF outperformed stable isotope analysis ($\delta^{13}C$, $\delta^{15}N$), reducing overall classification error below 4%. XRF has the added advantage of providing samples every 200 µm on a single quill, enabling 100% classification accuracy by taking the consensus of votes per quill. This accurate and cost-effective forensic technique could provide a much needed *in situ* solution for combating the illegal laundering of wildlife, and conversely, assist with certification of legally bred animals.

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TARONGA CONSERVATION SOCIETY AUSTRALIA For the Wild
UTS UNIVERSITY OF TECHNOLOGY SYDNEY
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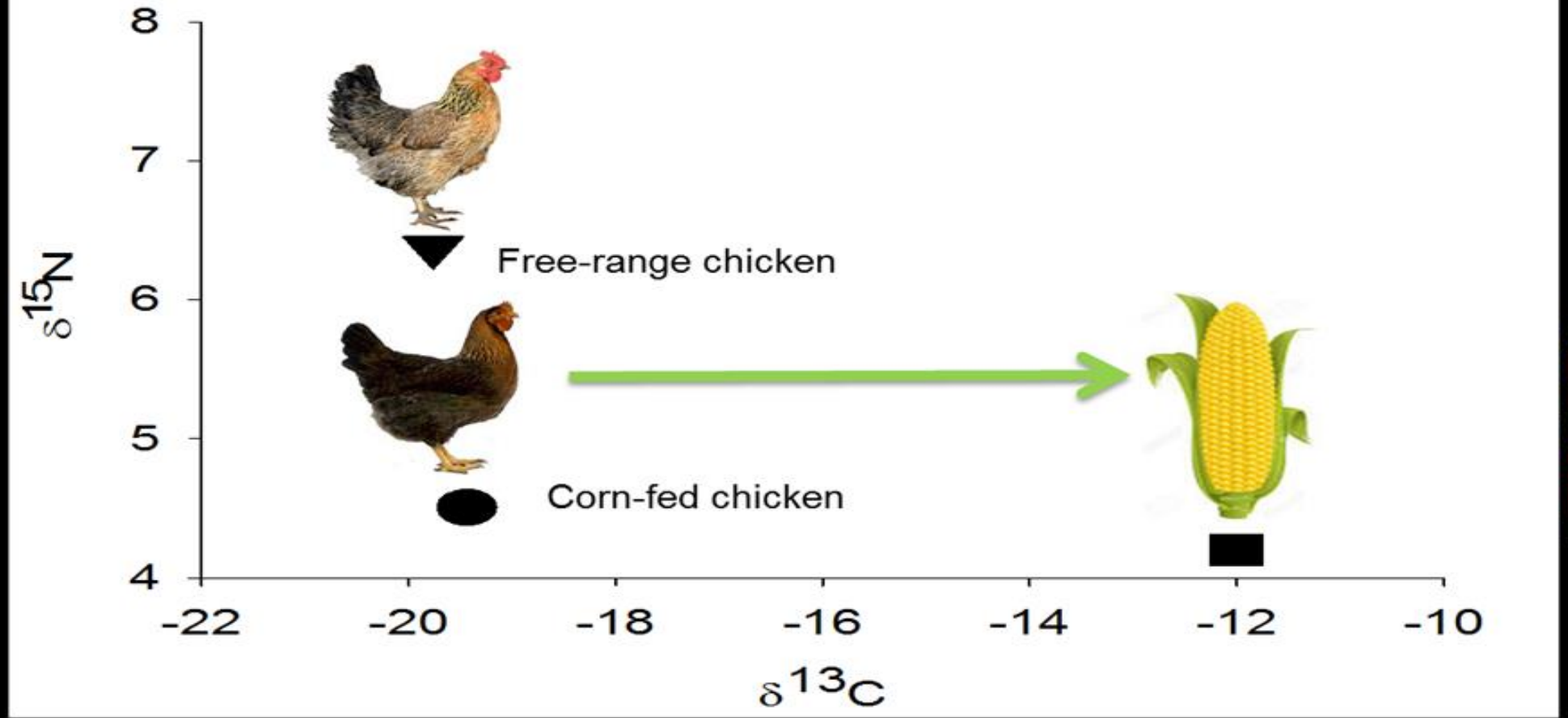
# Testing chicken meat

## Isotopic analysis to authenticate foods




SIA $\delta^{13}C$ $\delta^{15}N$


**Food fraud is costing the global food industry $50 billion annually**

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# Benefits of food provenance technology

- **Detailed and scientifically-validated model, help build consumer confidence in premium products, nationally and internationally.**
- **This technique provides accountability, which may act as a deterrent to fraudulent practices and avoid the need for court cases.**
- **The method will help the food industries with branding their produce and complement certification methods.**
- **This method has the potential to develop unique fingerprints for sustainable produce, which is important for food and agri-businesses.**

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