



應用數位工具 於 農業產銷應用便利性

國立臺灣大學生物資源暨農學院

生物環境系統工程系

林裕彬

2020.10.30

Content

- 農業面臨的挑戰
- E化農業演進
- 數位化工具之應用
 - ✓ 區塊鏈 (Blockchain)
 - ✓ 知識圖譜 (Knowledge graph)

- 案例說明

- 結語



農業面臨的挑戰與機會



全球農業環境面臨的挑戰

糧食安全與農業環境安全息息相關

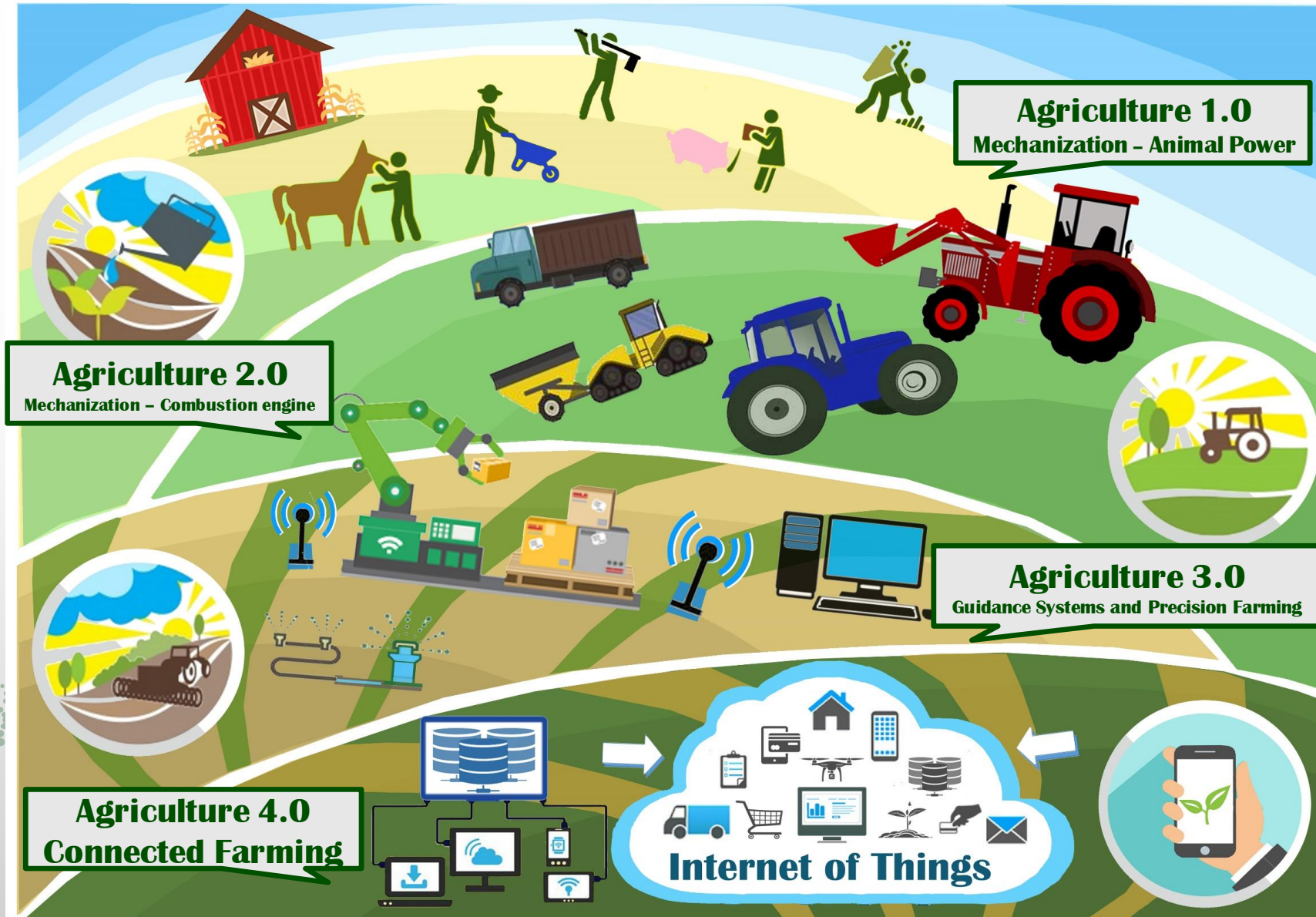
- 地表水資源分佈極不均勻
- 肥料和農藥低效利用
- 灌溉農業的鹽化
- 農業環境污染對作物的影響
- 糧食安全
- 氣候變遷
-

- 科技的進步
- 人類思維的改變
- 全球化
-

農業的演進

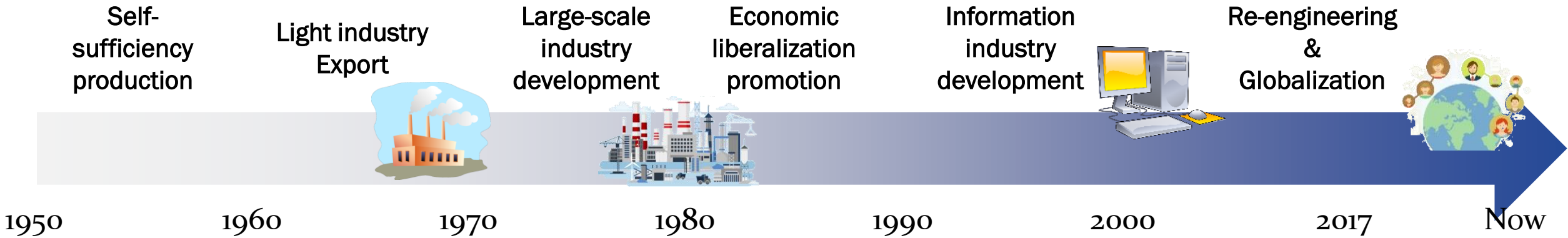


E化農業的挑戰與演進



台灣農業與經濟發展

台灣經濟發展



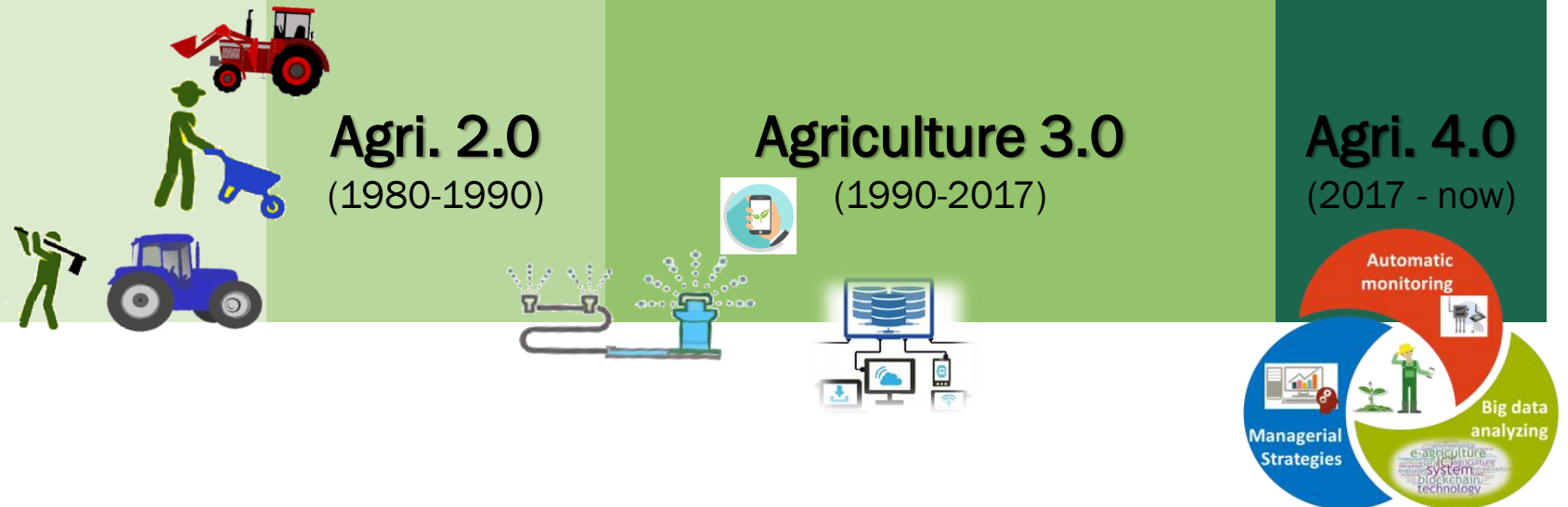
Agriculture 1.0
(1950-1980)

Agri. 2.0
(1980-1990)

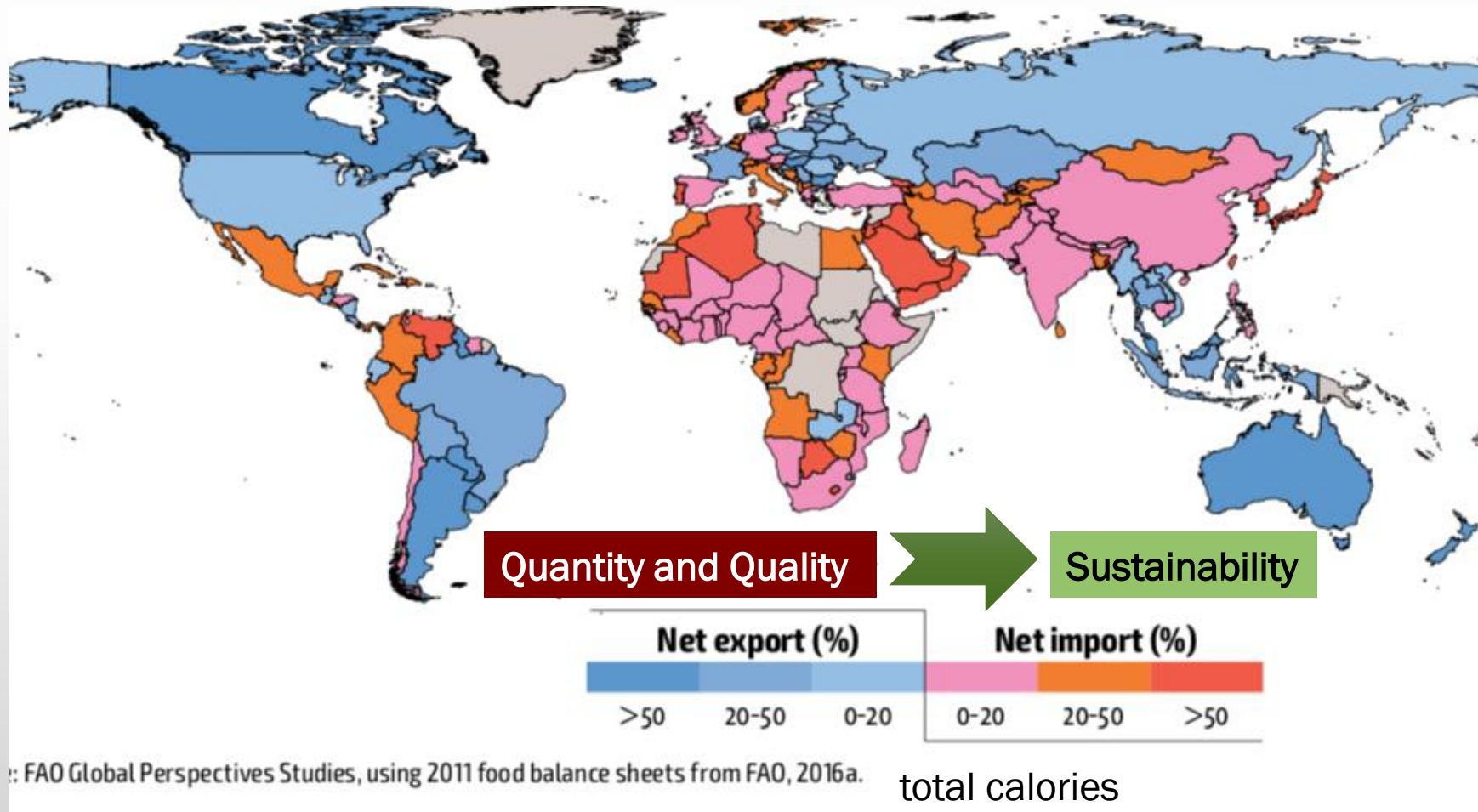
Agriculture 3.0
(1990-2017)

Agri. 4.0
(2017 - now)

台灣農業發展歷程



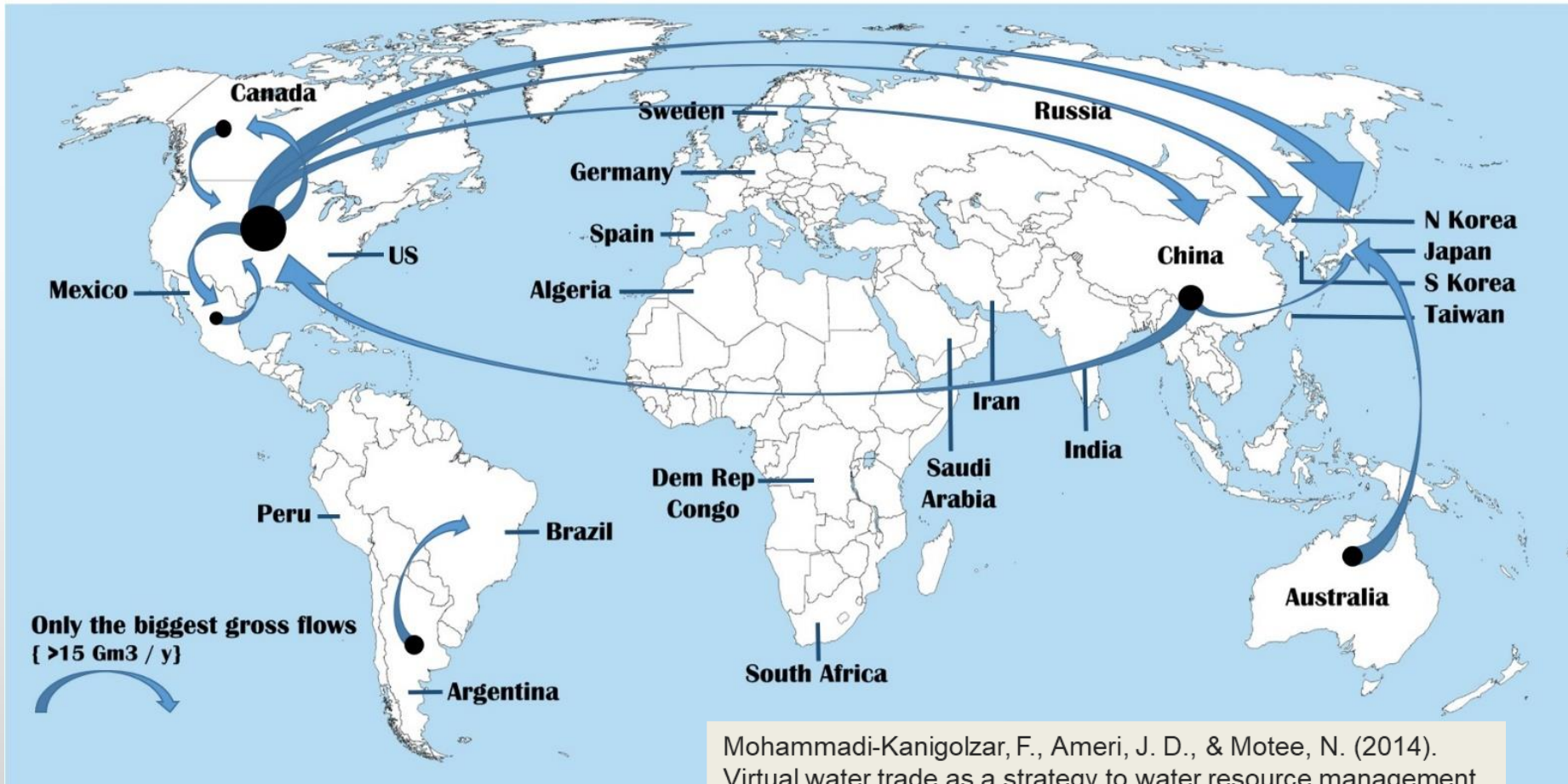
Net food imports in domestic food supply



Global Trade

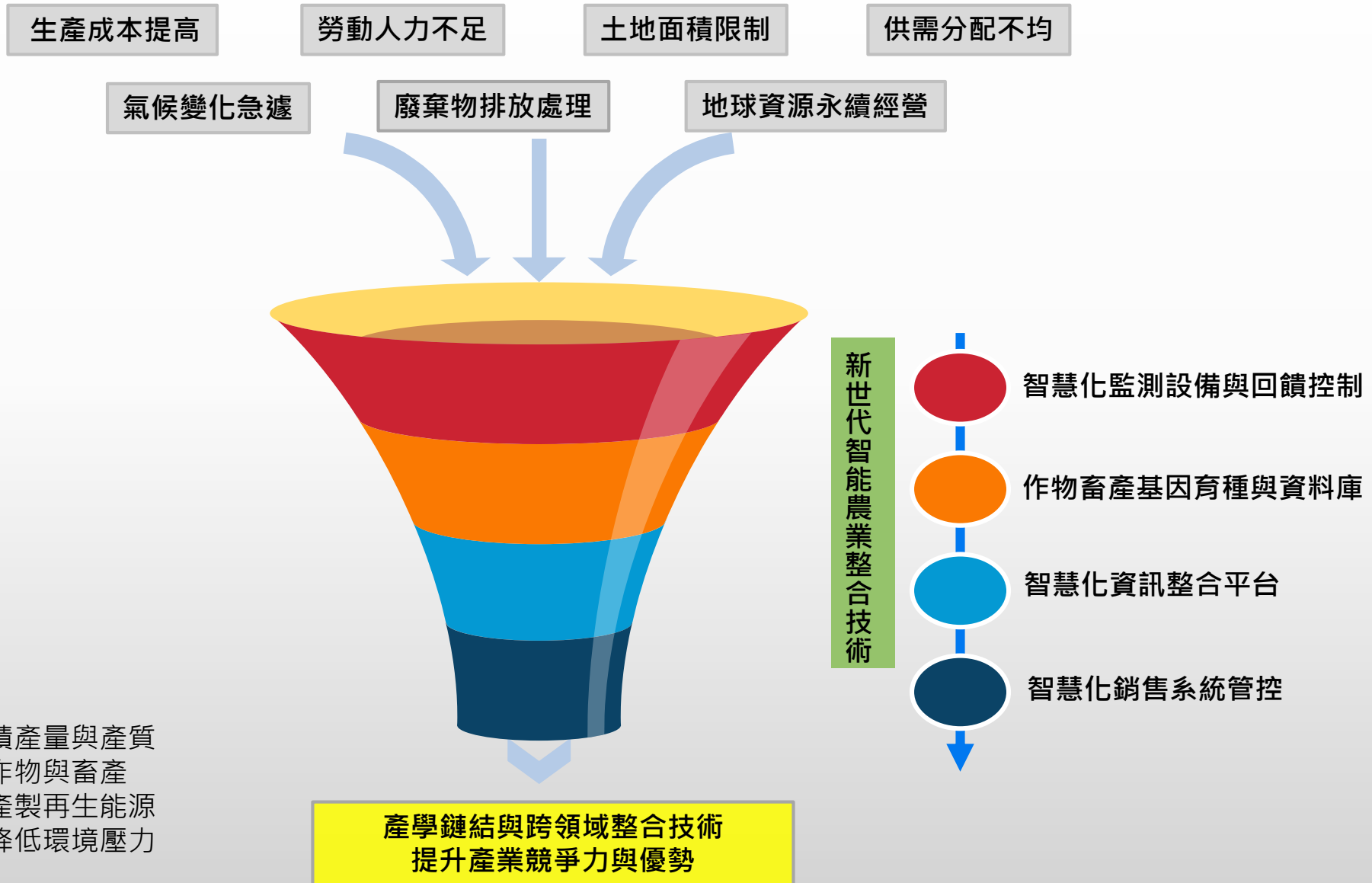
Virtual water balance

The exports and imports of water through food and commodities, 1996-2005



Mohammadi-Kanigolzar, F., Ameri, J. D., & Motee, N. (2014). Virtual water trade as a strategy to water resource management in Iran. *Journal of Water Resource and Protection*, 6(02), 141.

擬解決問題與方法



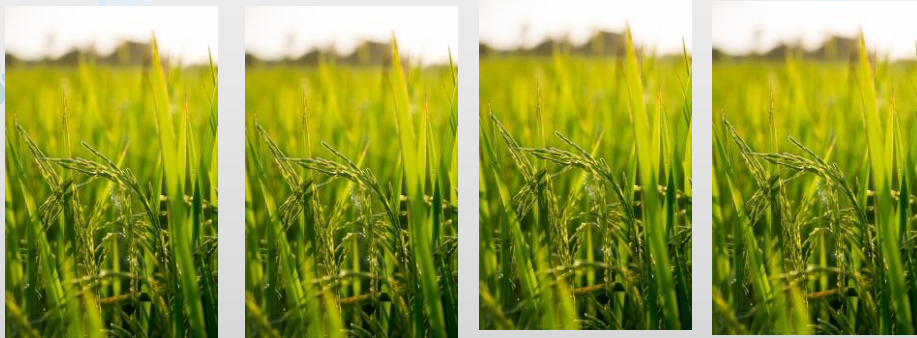
ICTs 在農業上的應用



Source: FAO, ITU

E-Agriculture

- **E-agriculture, or ICTs in agriculture**, is about designing, developing and applying innovative ways to use ICTs with a primary focus on agriculture.
- **E-agriculture strategies will facilitate achieving the goals set by national agricultural plans** by addressing holistically the ICT opportunities and challenges for the agricultural sector.
- It would further enhance the potential for innovation in services and rational use of resources thereby **increasing business opportunities, reducing risks and improving the lives of people in rural communities.**



E-Agriculture

Food and Agriculture Organization of the United Nations

About FAO | In Action | Countries | Themes | Media | Publications | Statistics | Partnerships

e-agriculture

Home Activity Themes Countries News and Events Resources Forum Get Involved

News • 01.02.2019 [report](#)

E-Agriculture in Action: Blockchain for Agriculture

Food and Agriculture Organization of the United Nations ITU

**E-AGRICULTURE IN ACTION:
BLOCKCHAIN
FOR AGRICULTURE**
Opportunities and Challenges

Sign in to the e-Agriculture platform

username

password

[Lost password?](#)

SIGN IN

Become a member

As e-Agriculture Forum member you can contribute to ongoing discussions, receive regular updates via email and browse fellow members profiles

REGISTER

Links

Automatic monitoring



Managerial Strategies

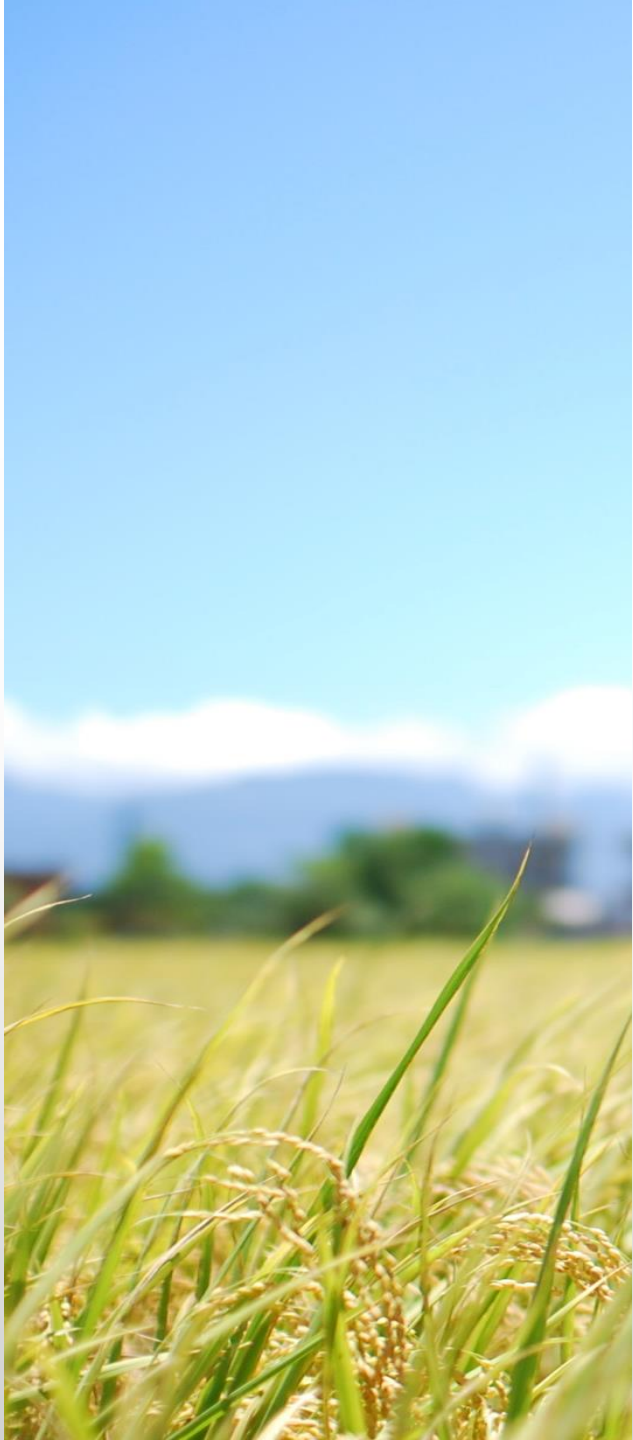
Big data analyzing



Lower costs and harm, higher productivity and quality.

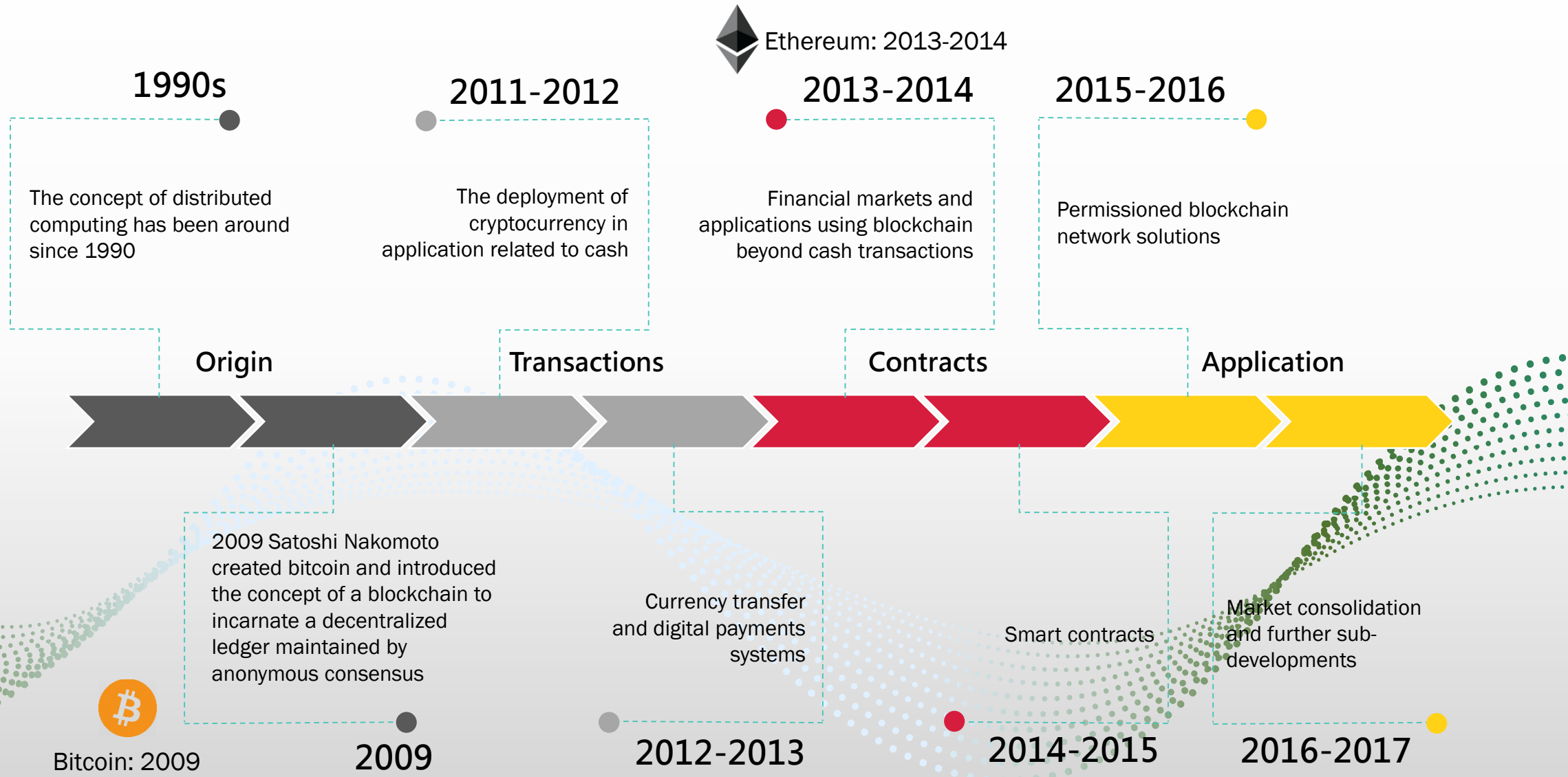
數位化工具之應用

The background is a colorful, stylized landscape. It features rolling green hills in the foreground, some with distinct diagonal stripes. A winding dirt path leads through the hills. The sky is a bright blue, filled with large, fluffy white clouds. In the distance, there are more hills and a few birds flying. The overall style is clean and modern, typical of a digital presentation slide.



區塊鏈簡介

區塊鏈歷史

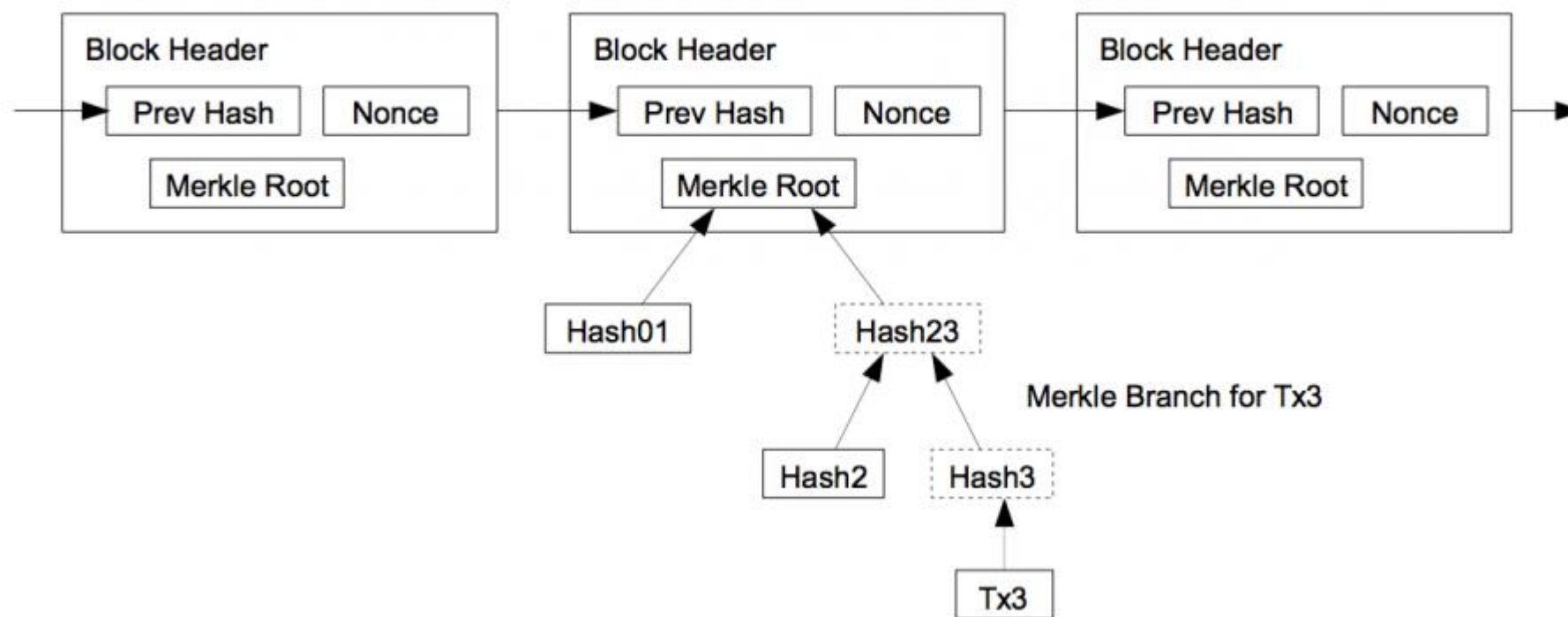


甚麼是區塊鏈

- 是一種「將資料寫錄的技術」
- 是一個「去中心化的分散式帳本(資料庫)」

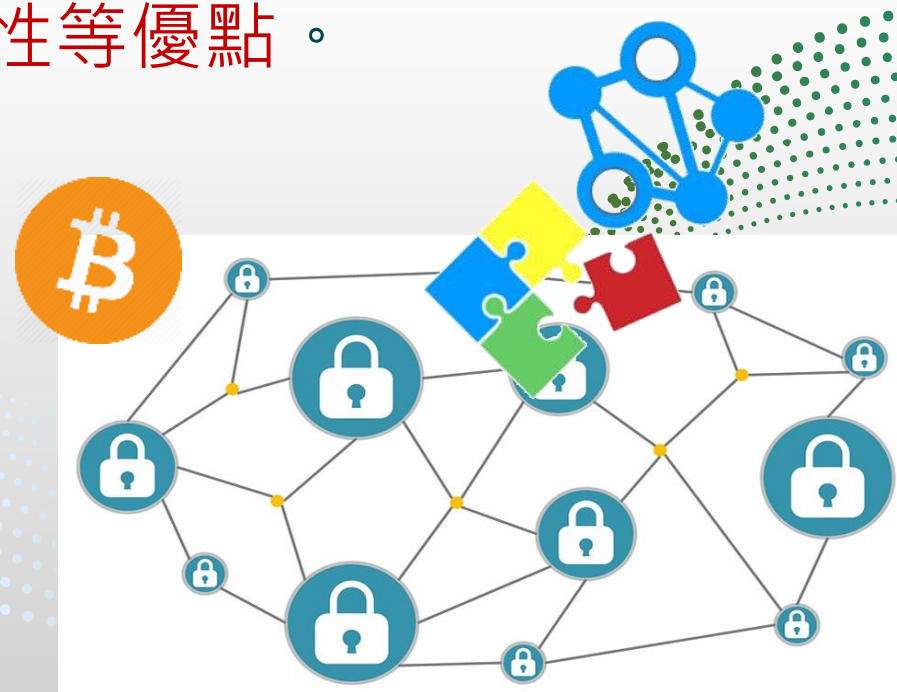


Longest Proof-of-Work Chain




甚麼是區塊鏈

- 區塊鏈起源於中本聰的比特幣，作為比特幣的基礎技術，本質上是個去中心化的資料庫。
- 區塊鏈將所發生的交易紀錄到區塊 (Block) 中，並藉由網絡參與者共同驗證的方式來確保交易的完整性，採用這項技術賦予金融機構去中介化、高安全性、結算速度快、成本較低、可供監察驗證和資料最終性等優點。



區塊鏈平台版本

- 比特幣 (Bitcoin) 
- 以太坊 (Ethereum) -> smart contract
- Hyperledger
- Quorum
- R3 Corda
- Ripple



ethereum



HYPERLEDGER



Quorum™

c·rda



區塊鏈類型

- 公有鏈：公開給全世界讀取、交易和審核的區塊鏈
- 私有鏈：私人化訂製可讀取資料的權限，限制對外公開
- 聯盟鏈：針對特定族群成員交流，權限靈活

	公有鏈	私有鏈	聯盟鏈
使用者	所有人	內部會員	聯盟會員
記帳者	所有參與者	私人化自訂	成員協商制定
特色	公開透明不可竄改	身分驗證隱私性高	私有鏈細化更靈活
代表	比特幣、ETH	金融數據管理	R3金融聯盟鏈

區塊鏈特色



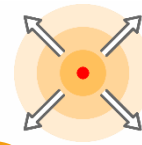
共同維護公開帳本 (Public Ledger)

加入區塊鏈的各方，共同維護並享有同一份紀錄交易的帳本，在共同的資訊平台運作。



防止抹滅或是竄改 (Tamper Resistant)

以雜湊函數(hash function)為基礎，能保障資訊的完整性，若資料被刪除或竄改，該區塊鏈的參與者必可察覺到資訊已被變更。



去中心化 (Decentralization)

區塊鏈以網路型態運作，無論是節點、數據或是使用者以點對點的方式連結。

去中心化

共同維護 公開帳本

區塊鏈 特色

自動解決 交易衝突



自動解決交易衝突 (Conflict Resolution)

當區塊鏈發生交易時，第二個使用同一批數位貨幣的交易即無法執行。

防止抹滅 或是竄改

具備時戳

具備時戳 (Time Stamps)

區塊鏈參與者共用一時間軸，當資料變更時，都會註記時戳。



區塊鏈技術在農業領域的應用

1. 物聯網監測資訊結合區塊鏈技術

2. 大數據分析結合區塊鏈技術

3. 應用區塊鏈技術進行品質安全追溯

4. 應用區塊鏈技術簡化農業金融服務

5. 應用區塊鏈技術簡化農業保險審核

6. 應用區塊鏈技術進行供應鏈管理

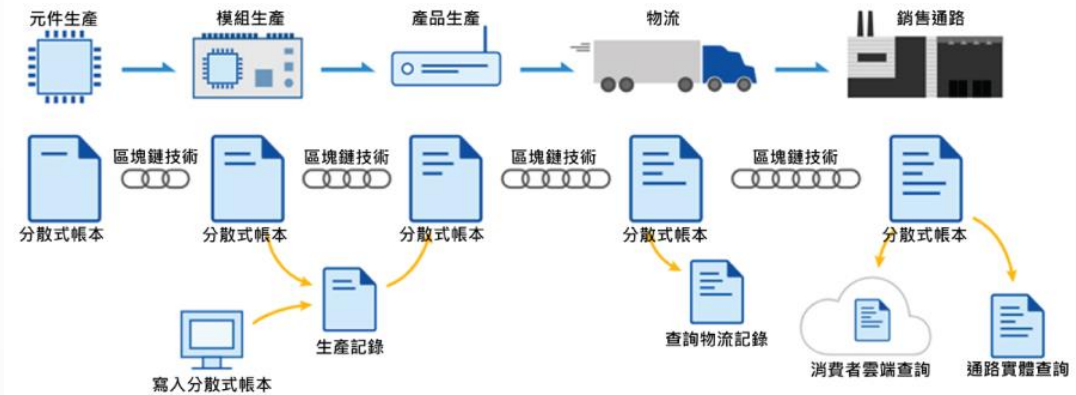


圖2：區塊鏈技術應用於供應鏈管理



- ✓ 作物生產數位智慧履歷
- ✓ 應用於農業循環經濟
- ✓ 數位分身
- ✓ 分散雲
- ✓ 供應鏈

資料來源: 農委會電子報

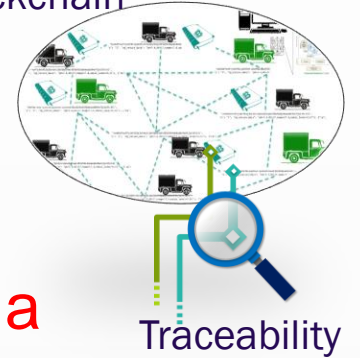
https://www.coa.gov.tw/office_epaper/epaper/infoexplorer/online/48/content_1.html

區塊鏈與供應鏈

➤ Blockchain Applications

- ✓ *Food traceability*
- ✓ *Balancing market access*
 - **adds value** to the current market by **establishing a ledger** in the network and **balancing market pricing**
 - **revolutionize traditional** commodity trading and hedging
 - **enables** verified transactions to be securely **shared with every player in the food supply chain**, creating a marketplace with immense transparency.

blockchain



➤ Blockchain Challenges

- ✓ *System Complexities*
- ✓ *Data Transparency*

區塊鏈將如何改變食品供鏈

➤ Solutions

- ✓ *The combination of IoT, blockchain, machine learning, and artificial intelligence are used to build a fully-transparent food supply chain.*
- ✓ *Some platforms are built to provide growers and different players along the value chain for sharing data and tracking progress.*

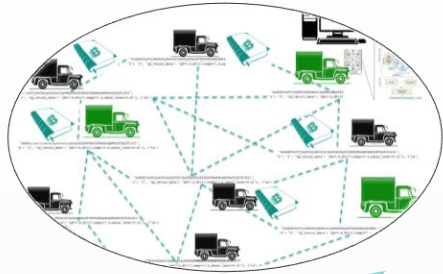
知識

PLUGANDPLAY

BLOCKCHAIN IN FOOD MARKET MAP

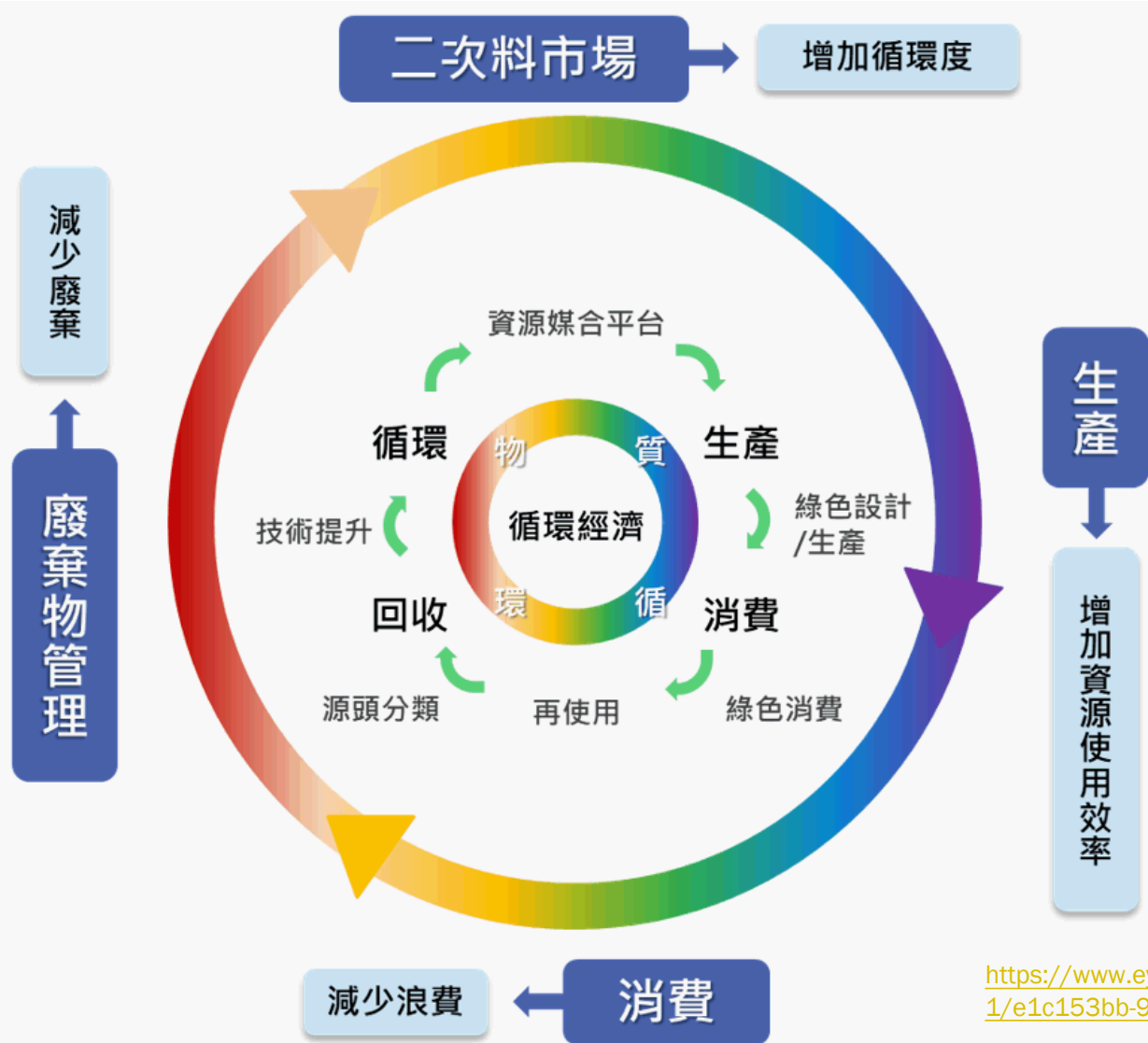


廢棄物管理邁向循環經濟策略



知識區塊鏈

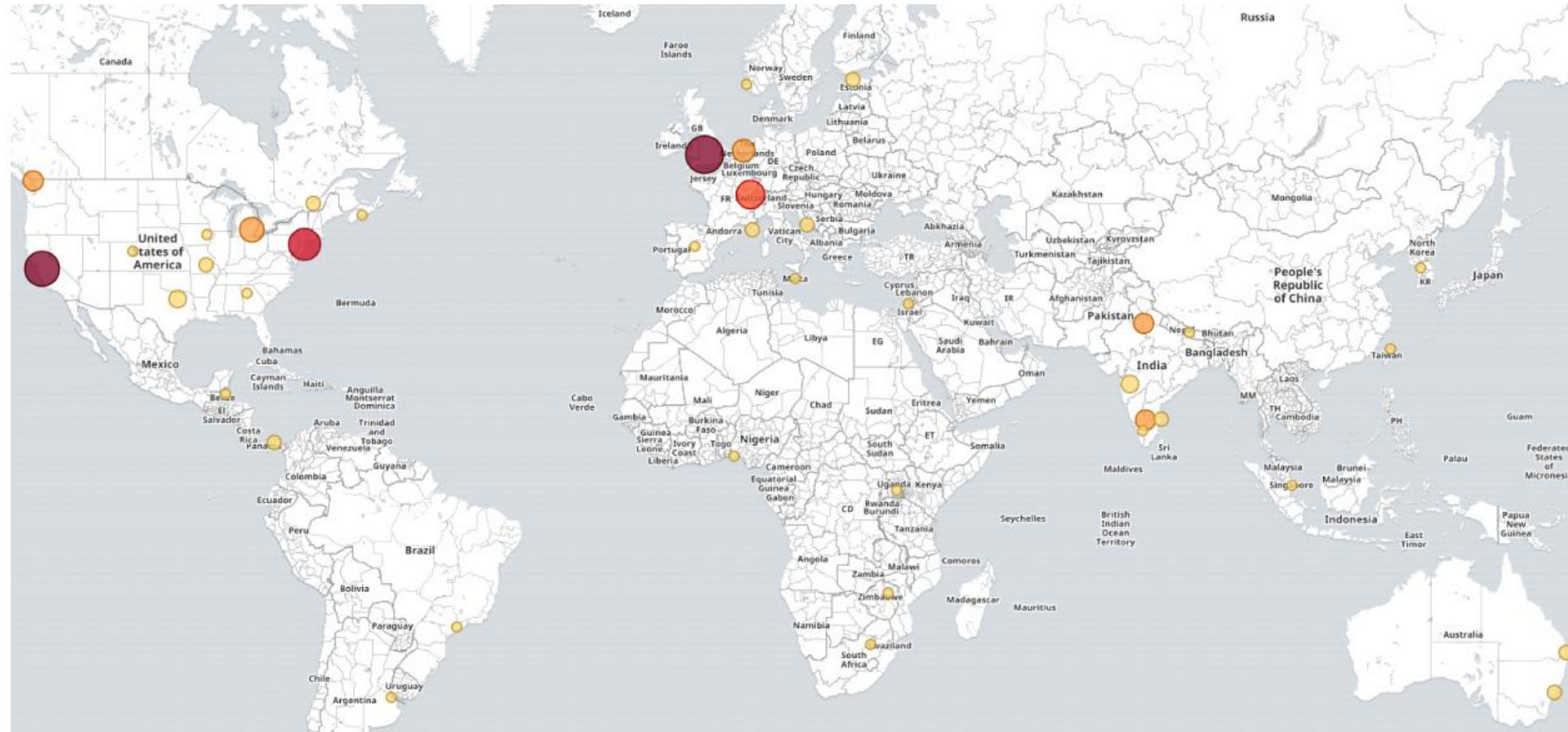
生命週期



區塊鏈技術在農業領域的應用

Heat Map: Blockchain Startups Transforming Agriculture

December 2018



This Heat Map illustrates the geographical distribution of over 150 Blockchain startups disrupting agriculture.

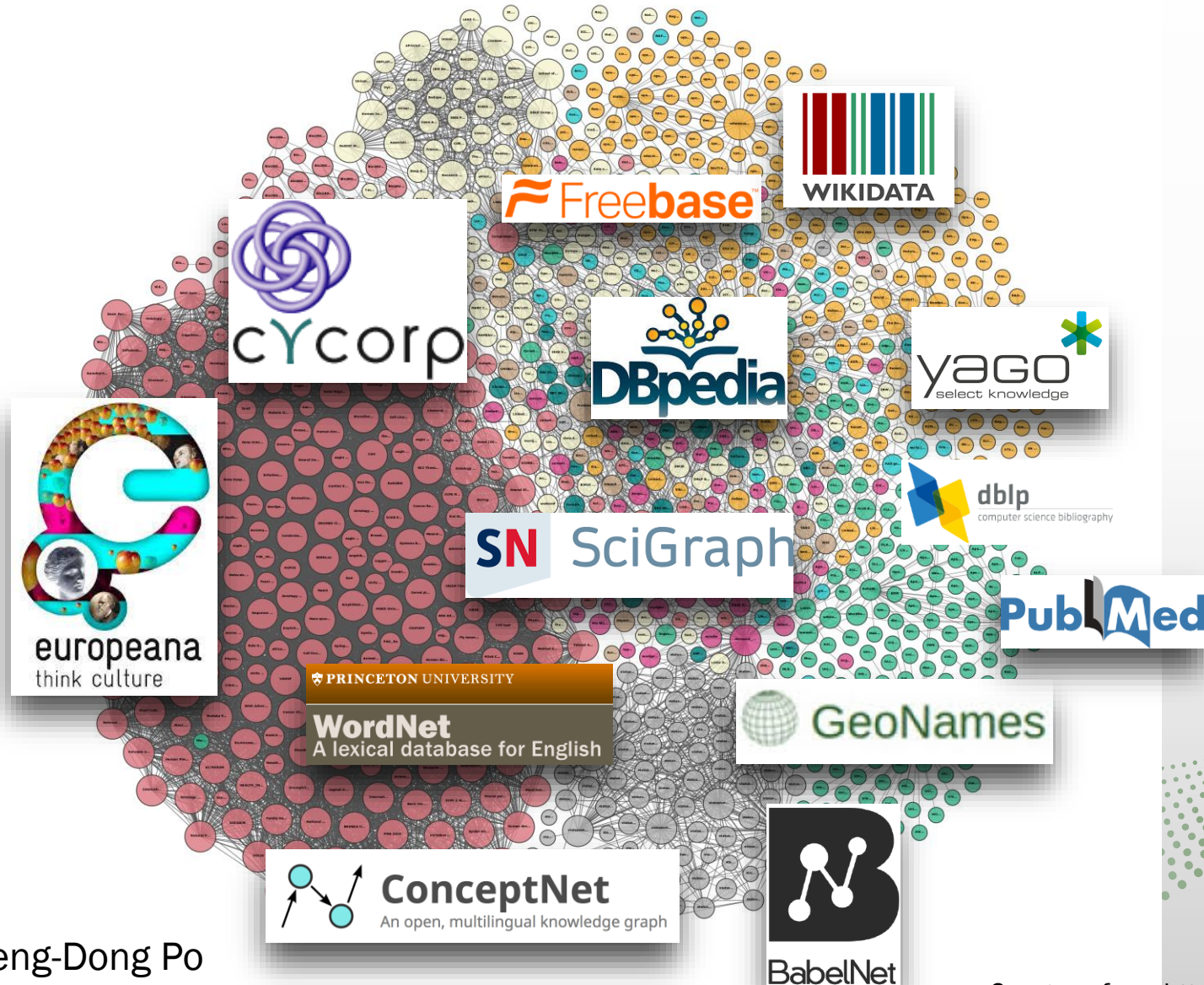


<https://www.startus-insights.com/innovators-guide/8-blockchain-startups-disrupting-the-agricultural-industry/>



知識圖譜

結合資料與知識圖譜

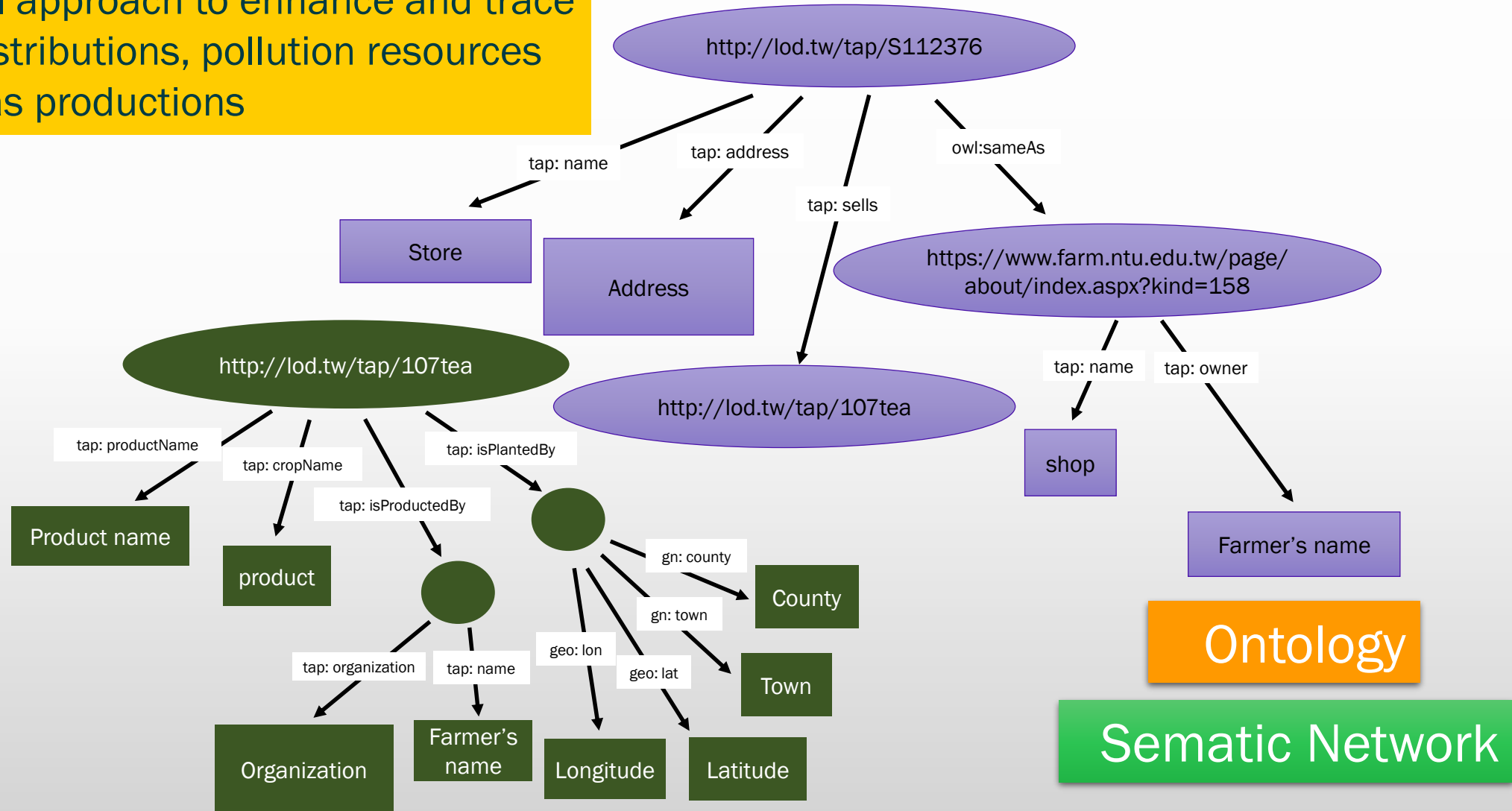


From Deng-Dong Po

Courtesy from <http://lod-cloud.net/>

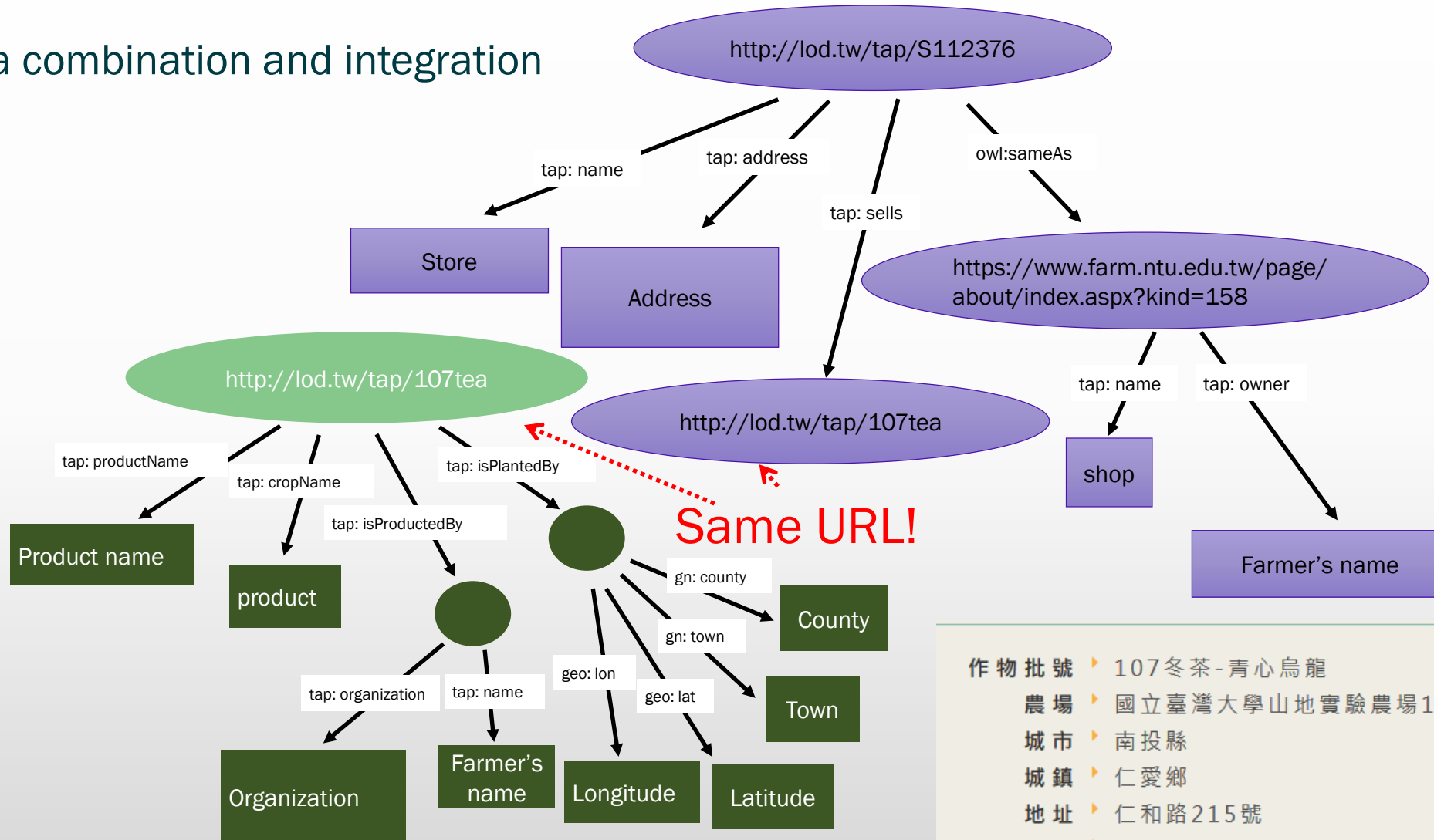
Adding Knowledge Graph

Graph with Information and knowledge potential approach to enhance and trace water distributions, pollution resources as well as productions



Adding Knowledge Graph

Data combination and integration



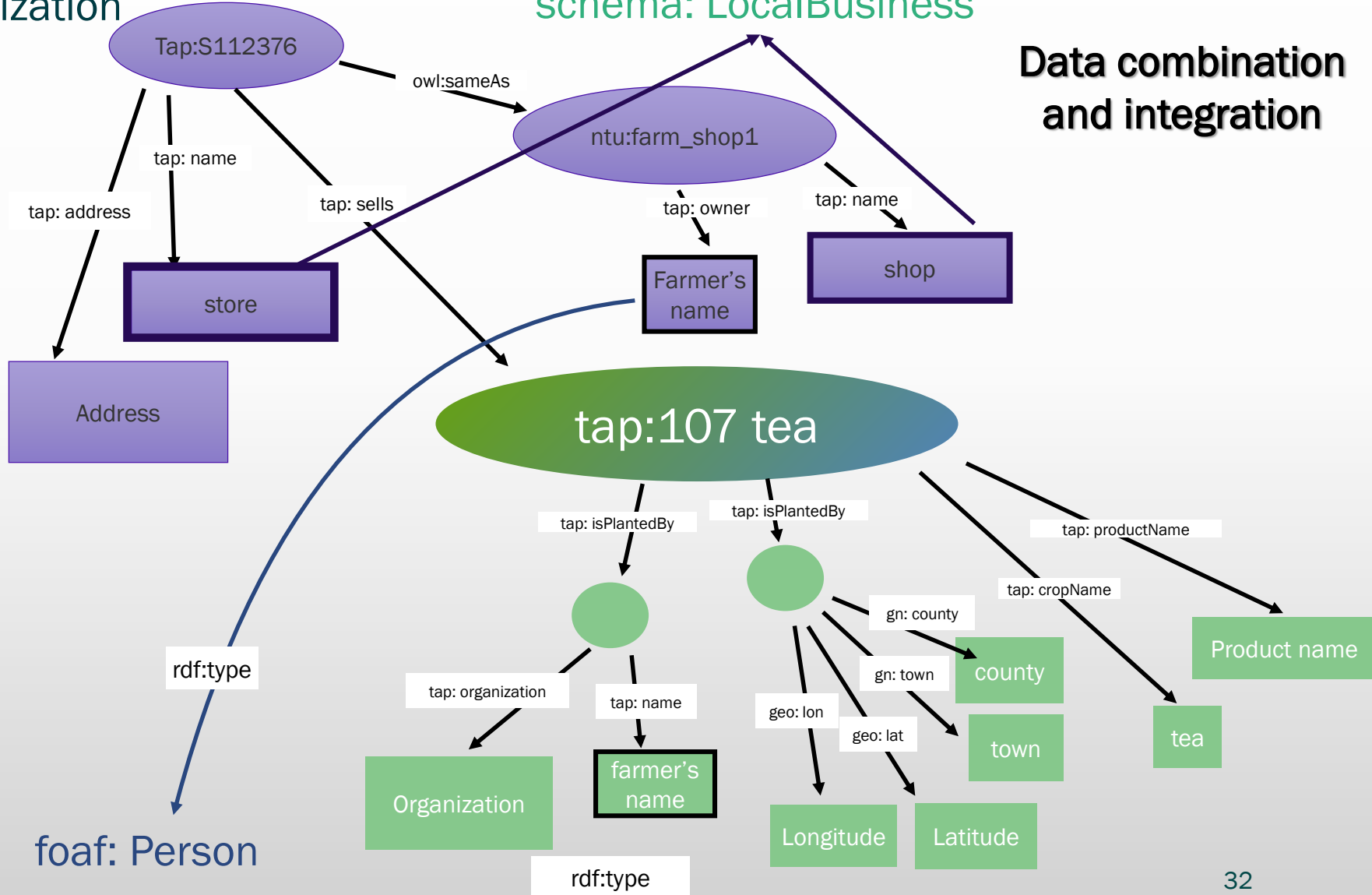
作物批號	▶ 107冬茶-青心烏龍
農場	▶ 國立臺灣大學山地實驗農場1
城市	▶ 南投縣
城鎮	▶ 仁愛鄉
地址	▶ 仁和路215號
電話	▶ 04 9280 3891
	▶ 更多資訊

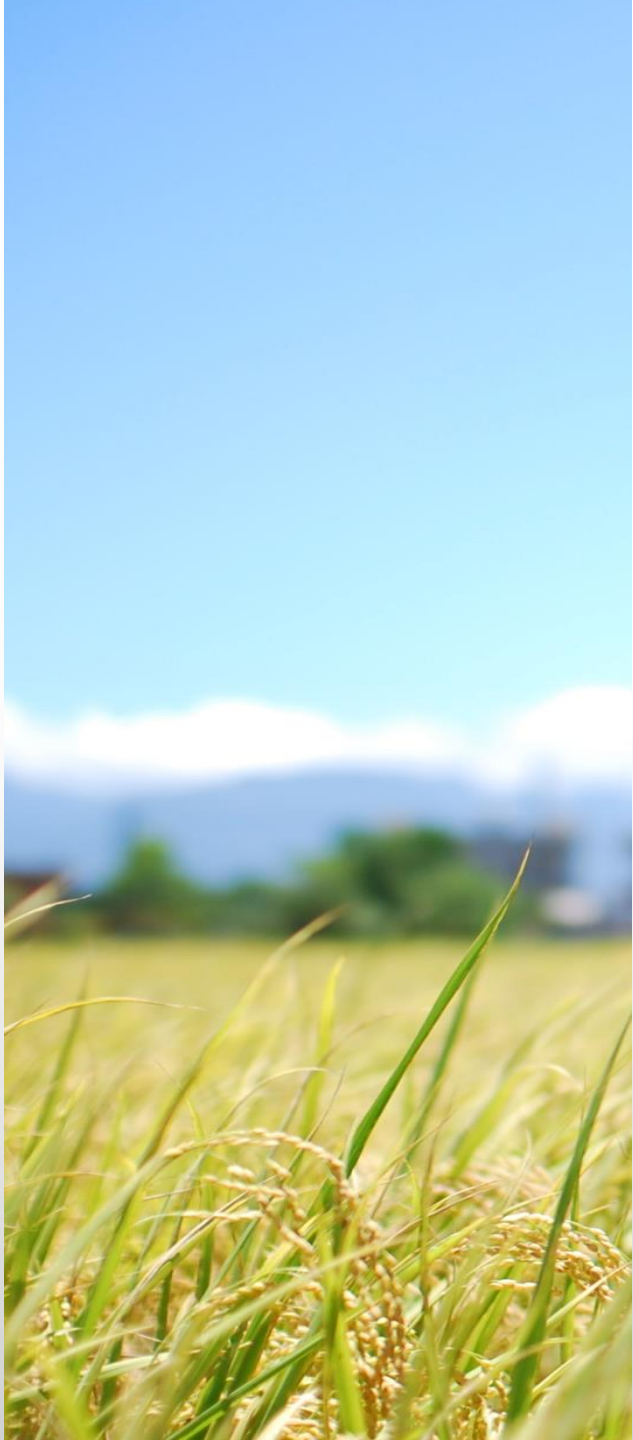
Adding Knowledge Graph

Data Normalization

schema: LocalBusiness

Data combination and integration





應用於作物生知識產履歷

Integration for Quality and Quantity

Inquire



Traceability
Agricultural Product



Customer



Safety



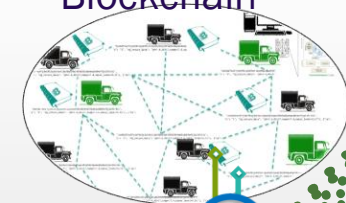
Production

Quality
Quantity

AI Knowledge AI

Security
Transparency

Blockchain



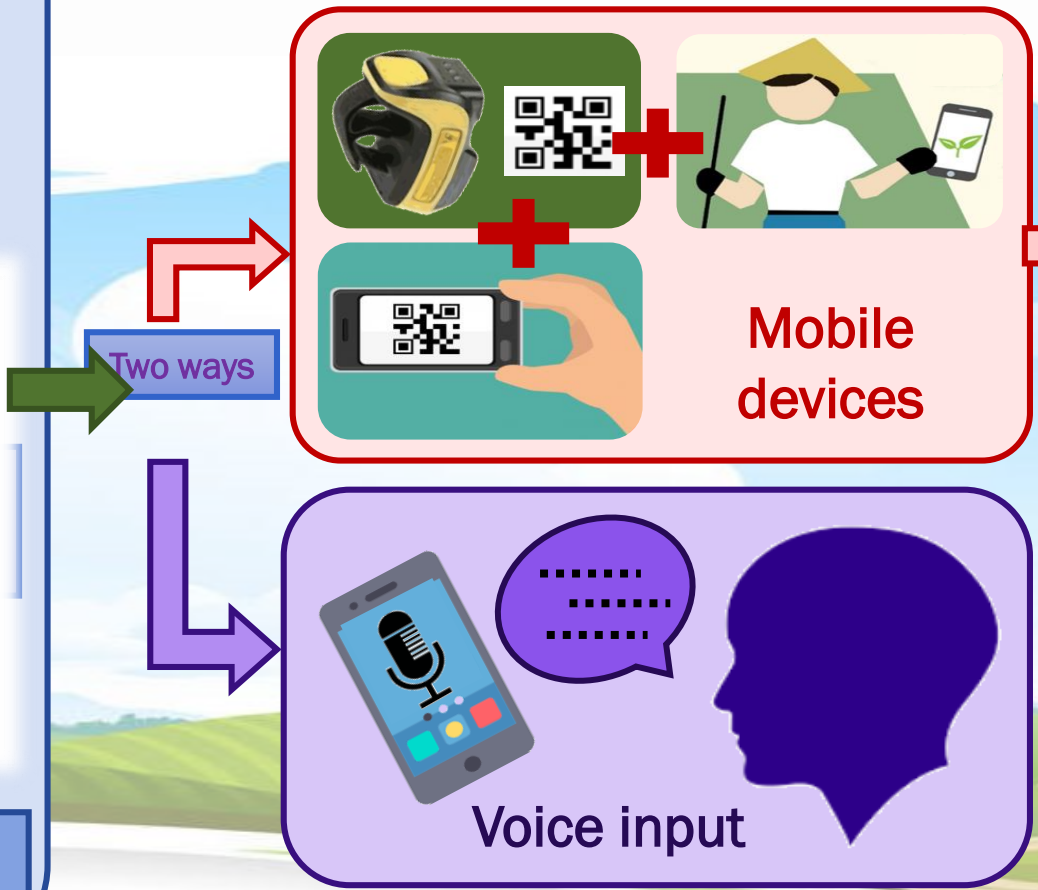
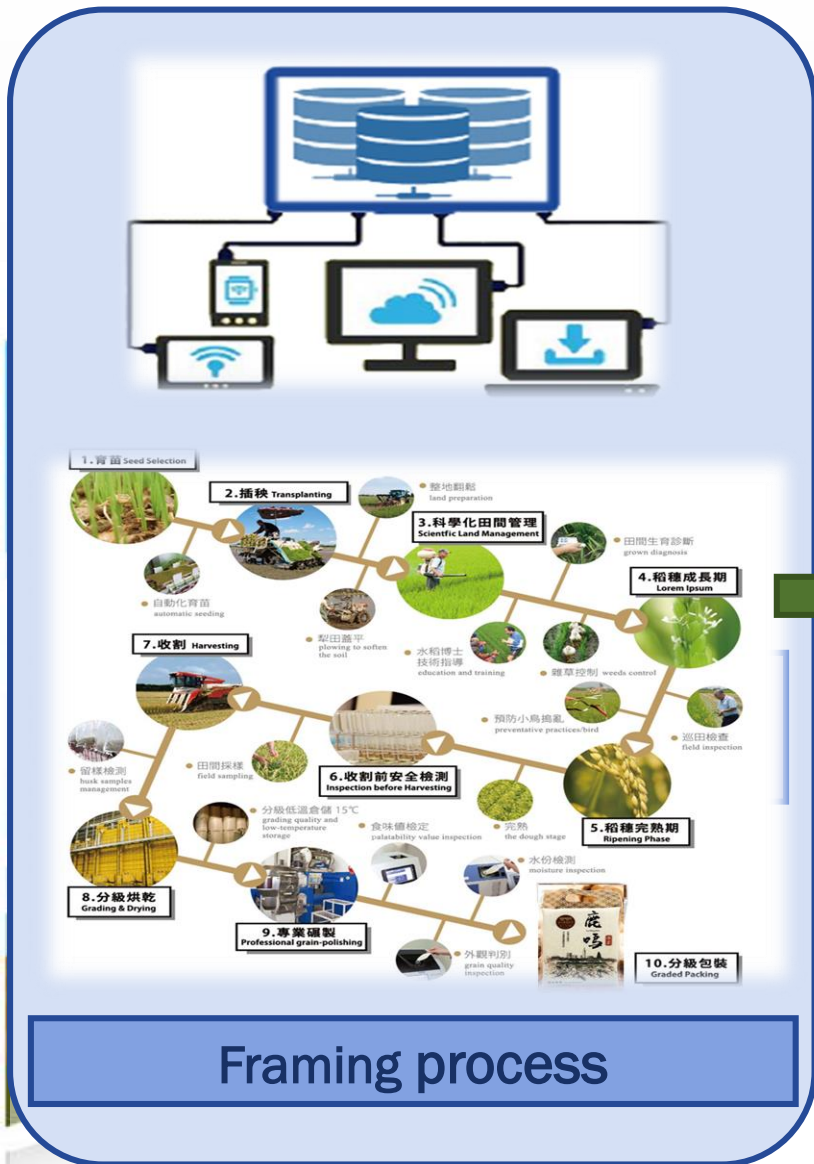
Traceability

Decentralize

Certification



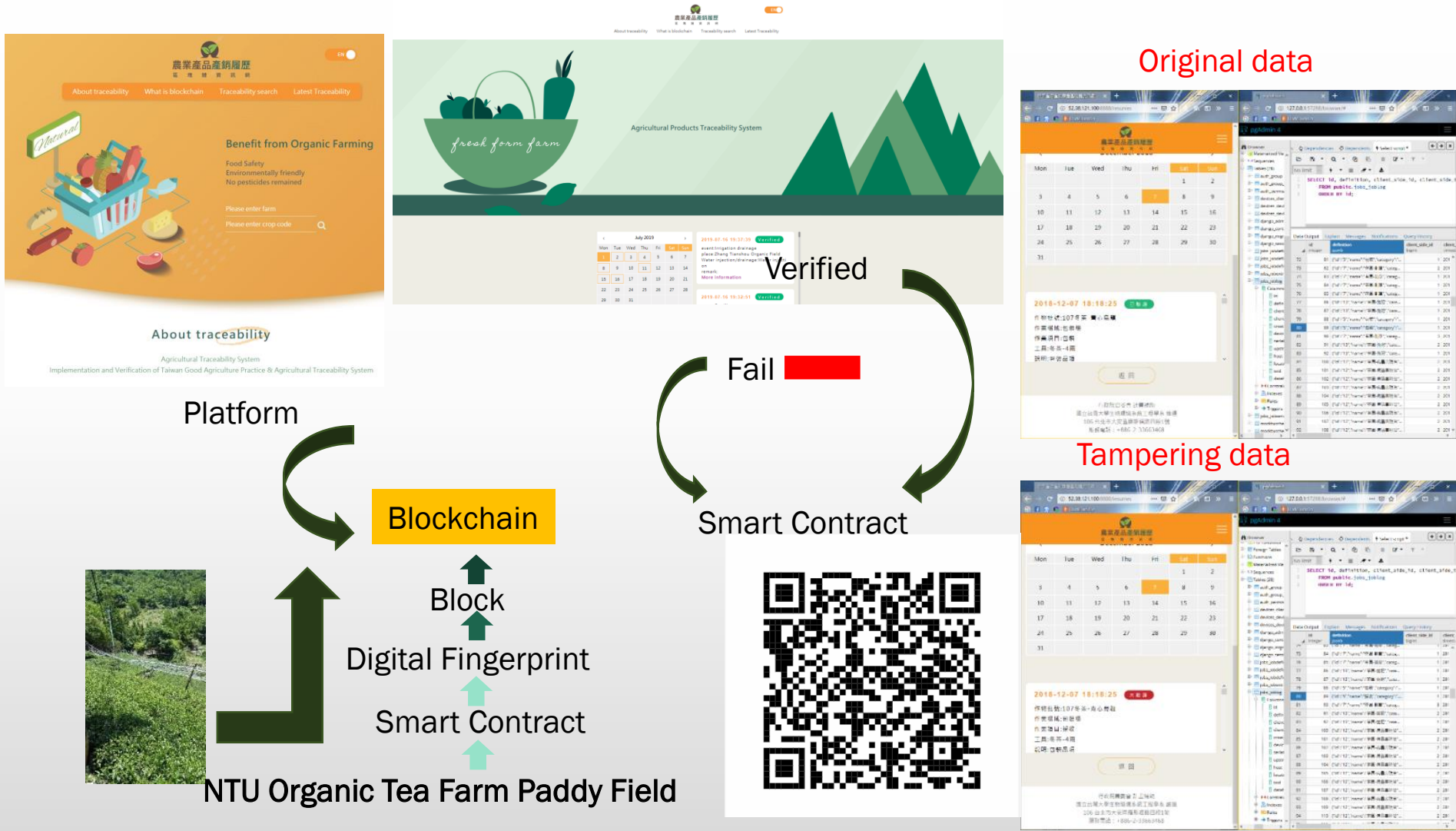
結合IoT技術於可追溯的農業生產系統管理



Two ways



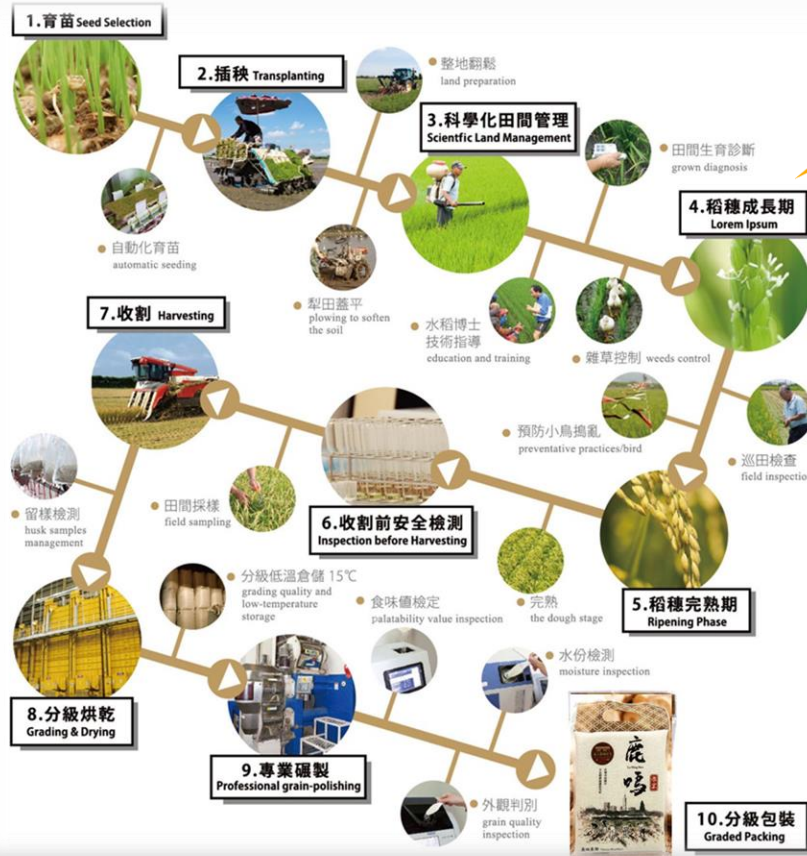
A Platform of Production Traceability



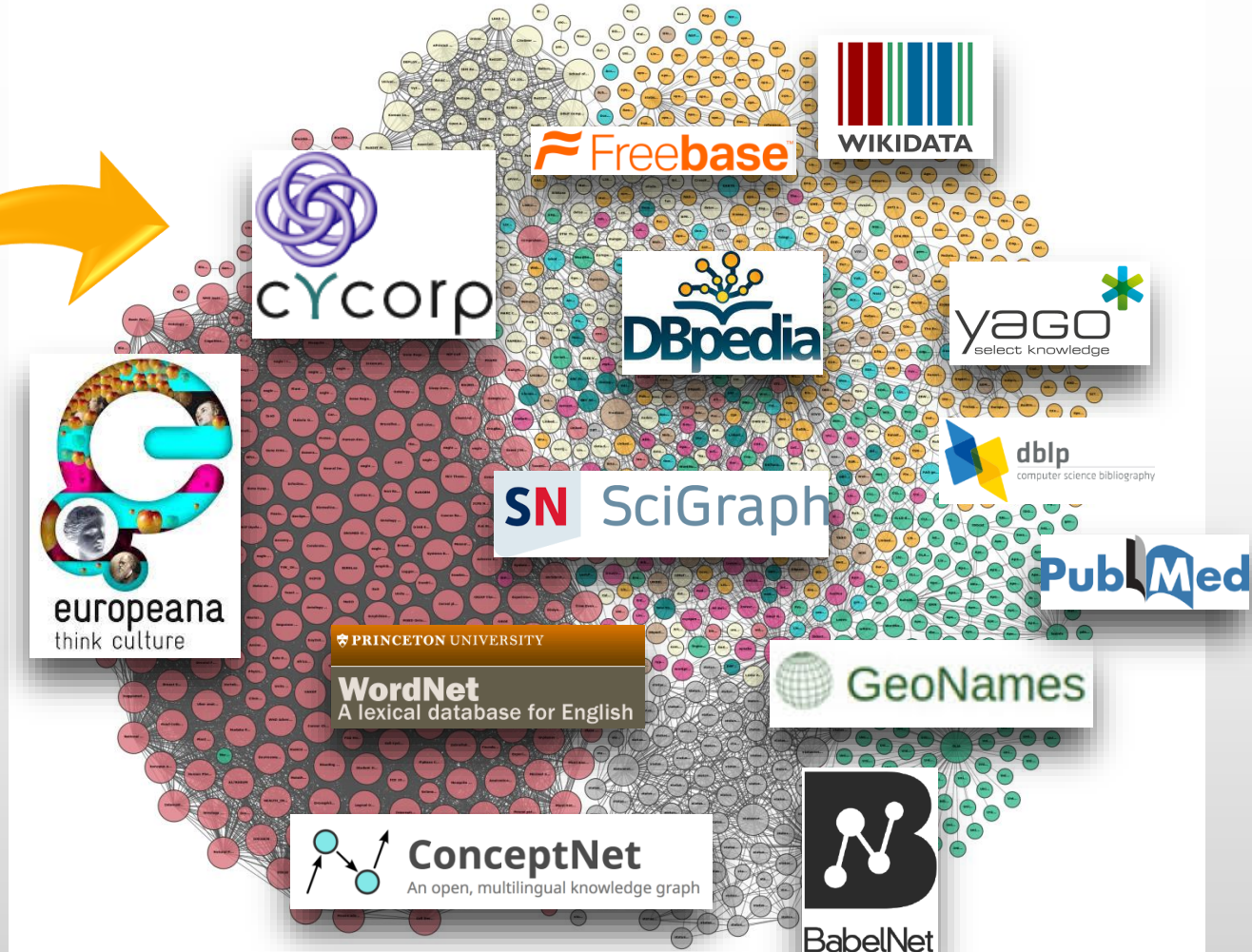
<http://140.112.76.152/>

數位分身之研究目標

智識加值型區塊鏈



知識圖譜



A Platform of Production Traceability

Platform

作物批號 ▶ 2019-2鹿鳴米_謝金男
農場 ▶ 壽米屋
城市 ▶ --
城鎮 ▶ --
地址 ▶ --
電話 ▶ --

更多資訊 區塊鏈智能合約

July 2019

Mon	Tue	Wed	Thu	Fri	Sat	Sun
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

2019-07-02 12:02:24 已驗證

作業項目:插秧
作業場域:謝金男有機田
工具:插秧機
備註:

2019-07-02 12:02:00 已驗證

作業項目:插秧
作業場域:謝金男有機田
工具:插秧機
備註:

QRcode



相機 4G 上午9:48 90% 不安全 140.112.76.152

農業產品產銷履歷
區塊鏈資訊網

作物批號 ▶ 2019-2鹿鳴米_謝金男
農場 ▶ 壽米屋
城市 ▶ --
城鎮 ▶ --
地址 ▶ --
電話 ▶ --

更多資訊 區塊鏈智能合約



inquire



Smart contract

Contract 0x84b69f71ADC3F2663698944DD0DB9e375974669

Contract Overview

Balance: 0 Ether

More Info

My Name Tag: Not Available

Contract Creator: 0xa85682c43169b7... at txn 0x50f517c35ebd58...

Transactions Contract Events

Code Read Contract Write Contract

Contract Source Code Verified (Exact Match)

Contract Name: FoodTraceability

Optimization Enabled: No with 200 runs

Compiler Version: v0.5.1+commit.c8a2cb62

Other Settings: default evmVersion: None license

Contract Source Code (Solidity)

```
1-/*++
2- *Submitted for verification at Etherscan.io on 2019-09-09
3- */
4-
5-pragma solidity ^0.5.1;
6-//pragma experimental:ABIEncoderV2;
7-
8-// 一個字樣影響一個合約
9- contract FoodTraceability {
10-     string public productString;
11-     string public productName;
12-     string public farm;
13-     bytes32 public latestHash;
14-
15-
16-     constructor(string memory _farm, string memory _productName) public{
17-         farm = _farm;
18-         productName = _productName;
```

Transaction data

Transaction Details

Sponsored by ETH % Cash! 50+ ways to buy & sell Ethereum (ETH). No verification, no wait! Buy & Sell Now

Overview State Changes New

[This is a Rinkeby Testnet Transaction Only]

Transaction Hash: 0x374ab4ae6a5a2165ea52fb36698dedb0204e021e112bdbe45ae1320c875d715

Status: Success

Block: 5059754 2846 Block Confirmations

Timestamp: 11 hrs 51 mins ago (Sep-09-2019 01:17:19 PM +UTC)

From: 0xa85682c43169b7e50a7d34bbf3c371a6f1c10c

To: Contract 0x84b69f71adc3f2663698944dd0db9e375974669

Value: 0 Ether (\$0.00)

Transaction Fee: 0.000170943 Ether (\$0.000000)

Gas Limit: 170.943

Gas Used by Transaction: 170.943 (100%)

Gas Price: 0.000000001 Ether (1 Gwei)

Nonce Position: 8 24

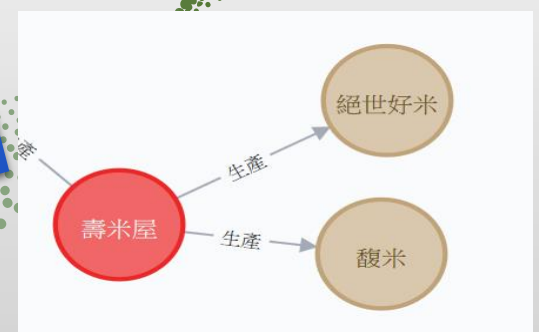
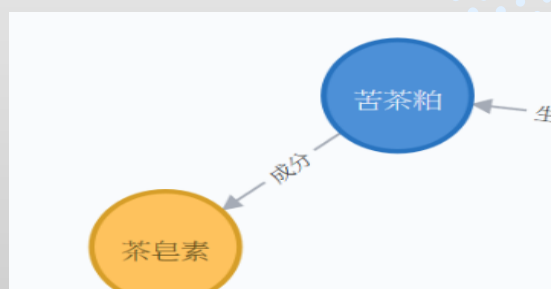
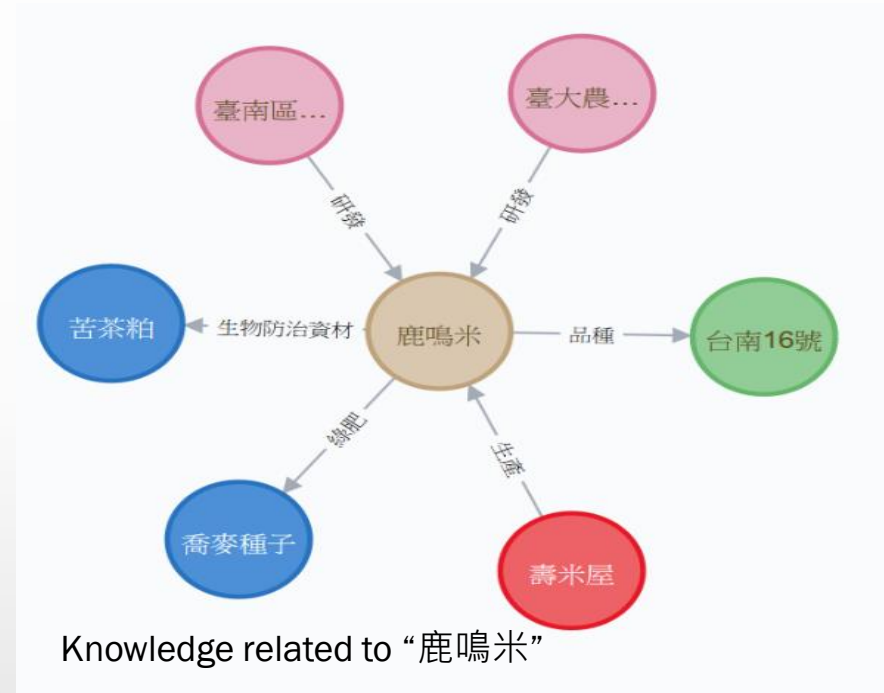
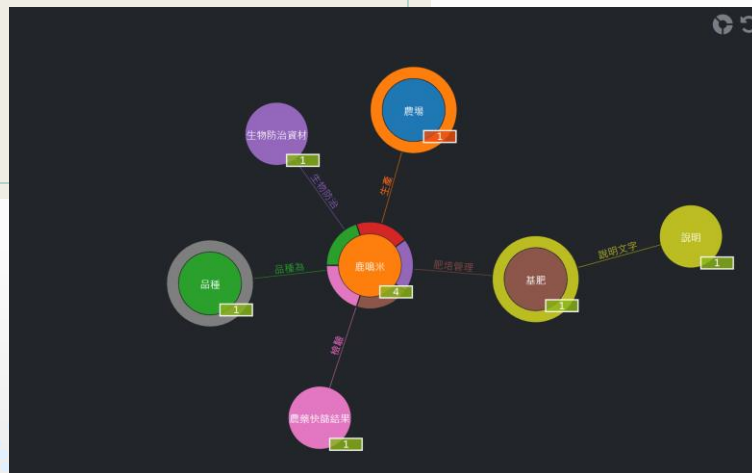
Input Data:

2	_location	string	謝金男有機田
3	_tool	string	插秧機

結合知識圖譜與區塊鏈

鹿鳴米

- 農場 ▶ 壽米屋
- 城市 ▶ 彰化縣
- 城鎮 ▶ 二林鎮
- 地址 ▶ 南光里儒林路2-3號
- 電話 ▶ 04 896 5111
- ▶ 知識圖譜 區塊鏈智能合約

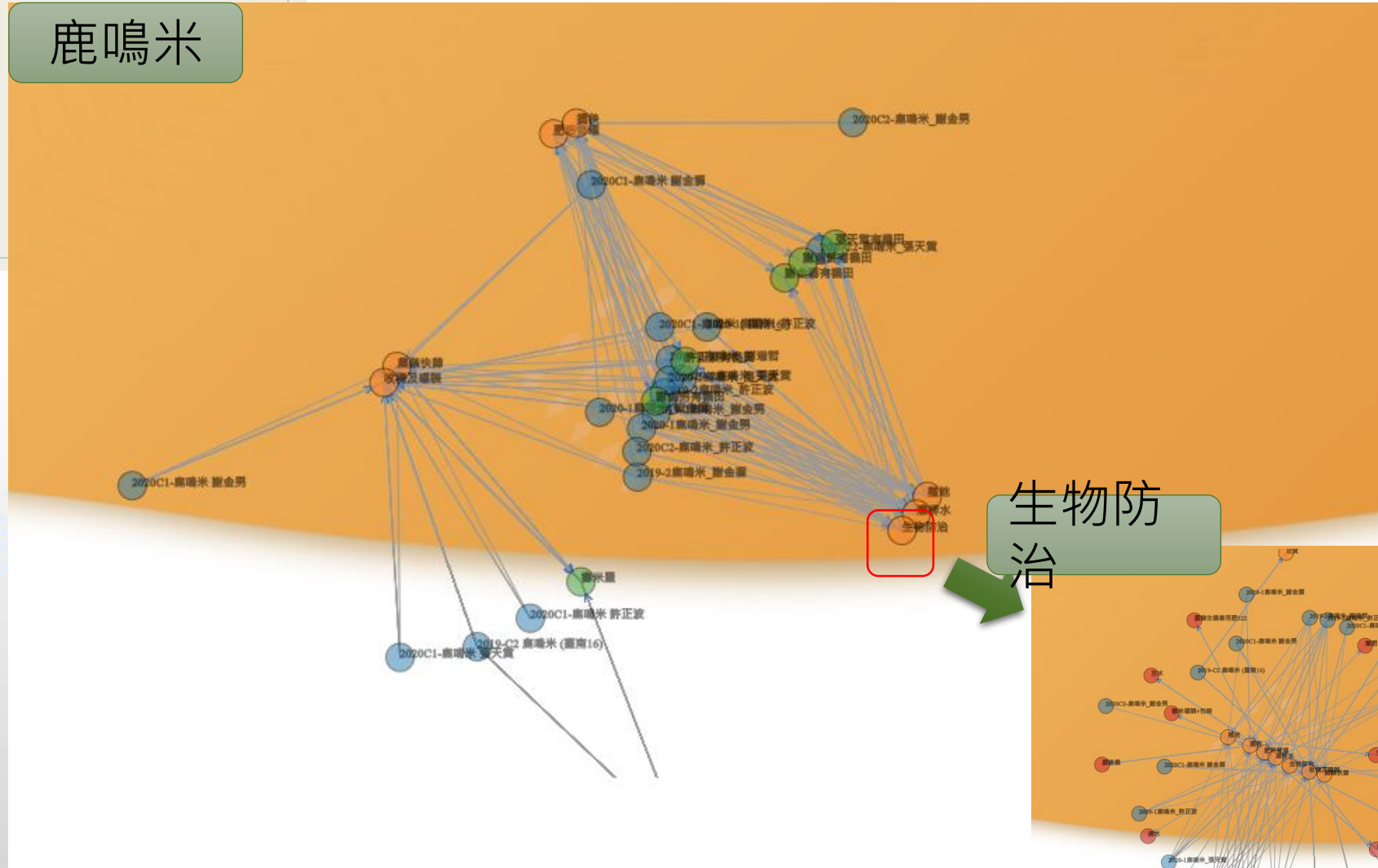


結合知識圖譜與區塊鏈

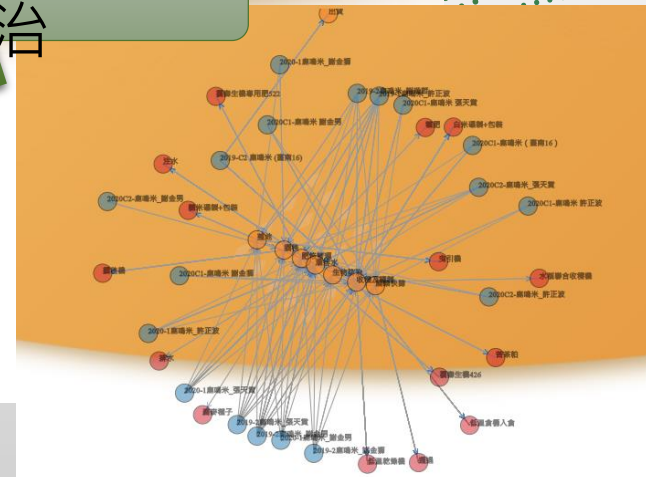
鹿鳴米

- 農場 ▶ 壽米屋
- 城市 ▶ 彰化縣
- 城鎮 ▶ 二林鎮
- 地址 ▶ 南光里儒林路2-3號
- 電話 ▶ 04 896 5111
- ▶ [知識圖譜](#) [區塊鏈智能合約](#)

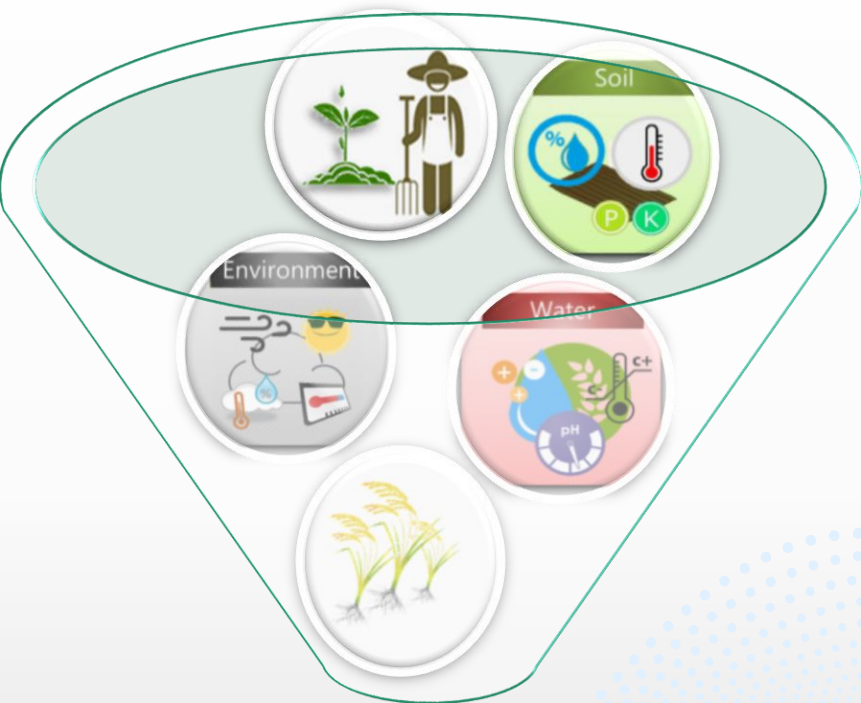
鹿鳴米



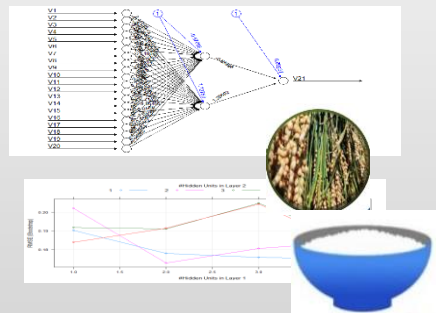
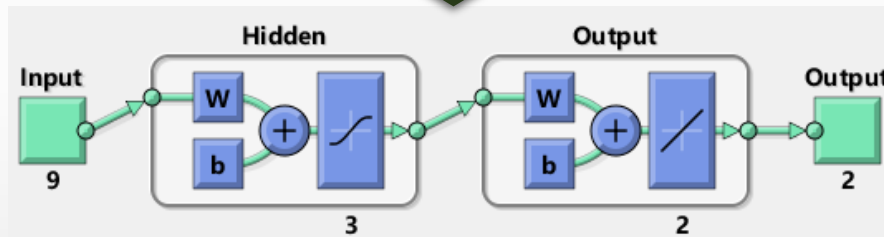
生物防治



食味值預測

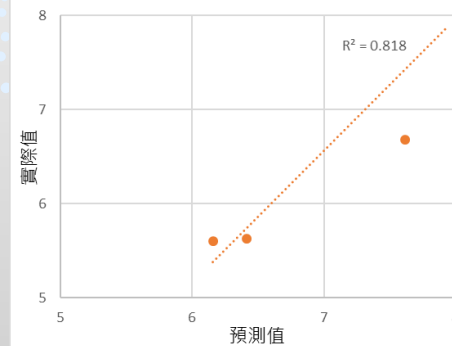


總肥施灑之作物積溫(°C)	收割之作物積溫(°C)	土壤溫度(°C)	水位(cm)	15公分土壤溫度(°C)	測站氣壓	相對溼度	風速	降水量	每公頃產量/Mt	食味值
726.95	1585.90	24.48	4.14	23.91	1011.44	87.77	2.32	447.00	6.68	73.50
690.60	1612.85	24.00	3.28	24.97	1008.98	87.51	2.23	685.00	8.32	69.60
410.25	1723.35	25.31	1.60	25.09	1010.75	87.83	2.32	665.50	8.38	74.33
914.45	1532.15	21.95	2.34	21.68	1012.08	87.52	2.34	366.00	7.19	75.33
548.40	1613.25	25.73	2.50	25.33	1011.59	87.55	2.33	447.00	8.48	74.83
487.20	1526.40	23.43	2.37	25.56	1012.00	87.62	2.34	366.00	7.86	73.00
618.00	1672.05	19.16	1.63	24.76	1010.25	88.01	2.31	655.50	8.02	76.75
786.90	1808.55	27.87	1.78	27.21	1004.21	86.15	2.35	602.00	6.72	69.00
771.70	1754.15	27.26	7.18	29.15	1005.18	84.62	2.44	521.00	5.78	73.50

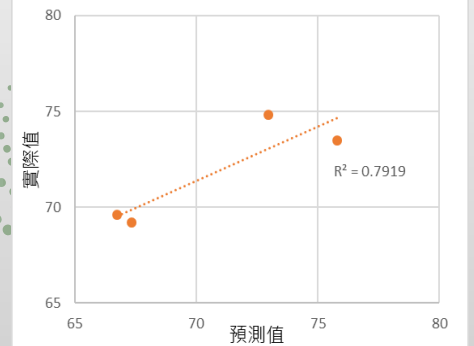


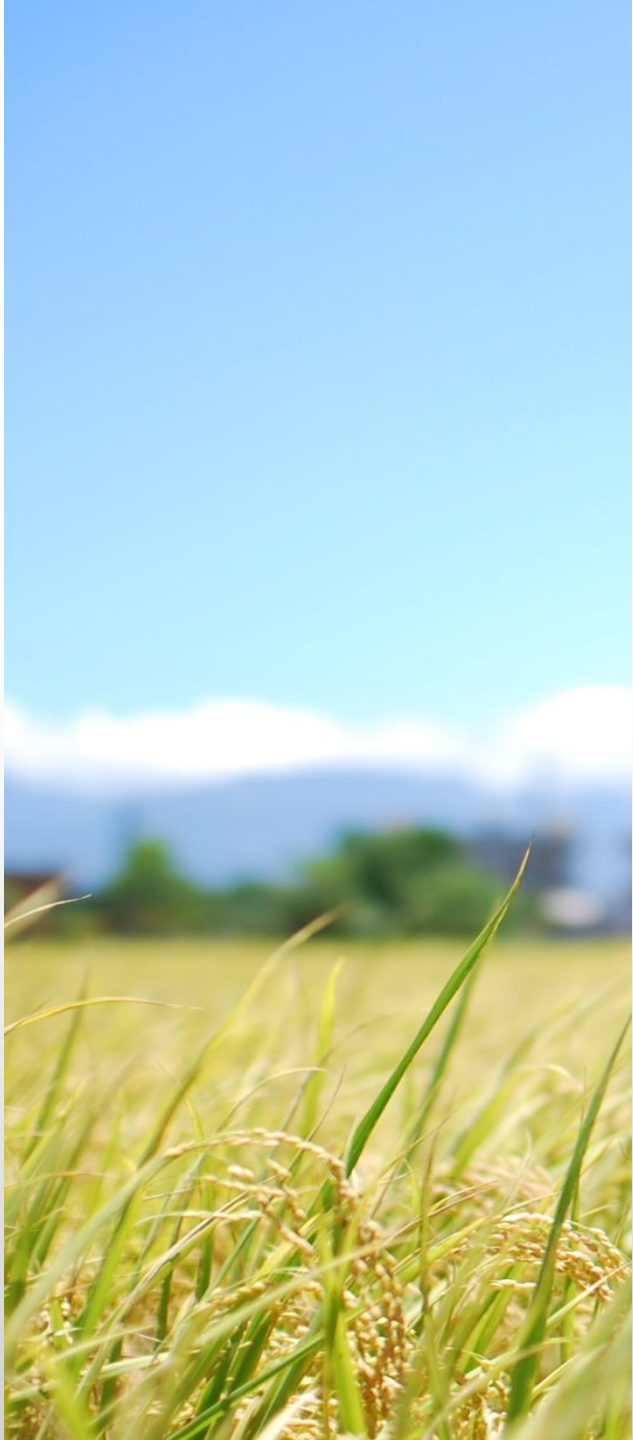
產量及食味值預測

產量預測(Mt/公頃)



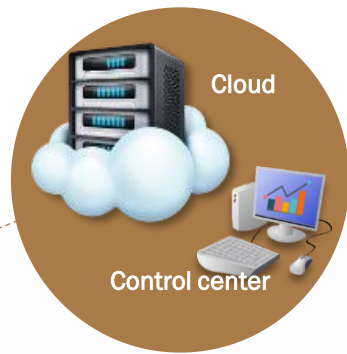
食味值預測





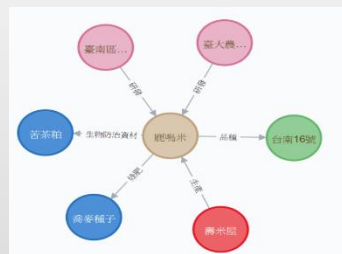
應用於農業循環經濟

區塊鏈應用於農業循環經濟

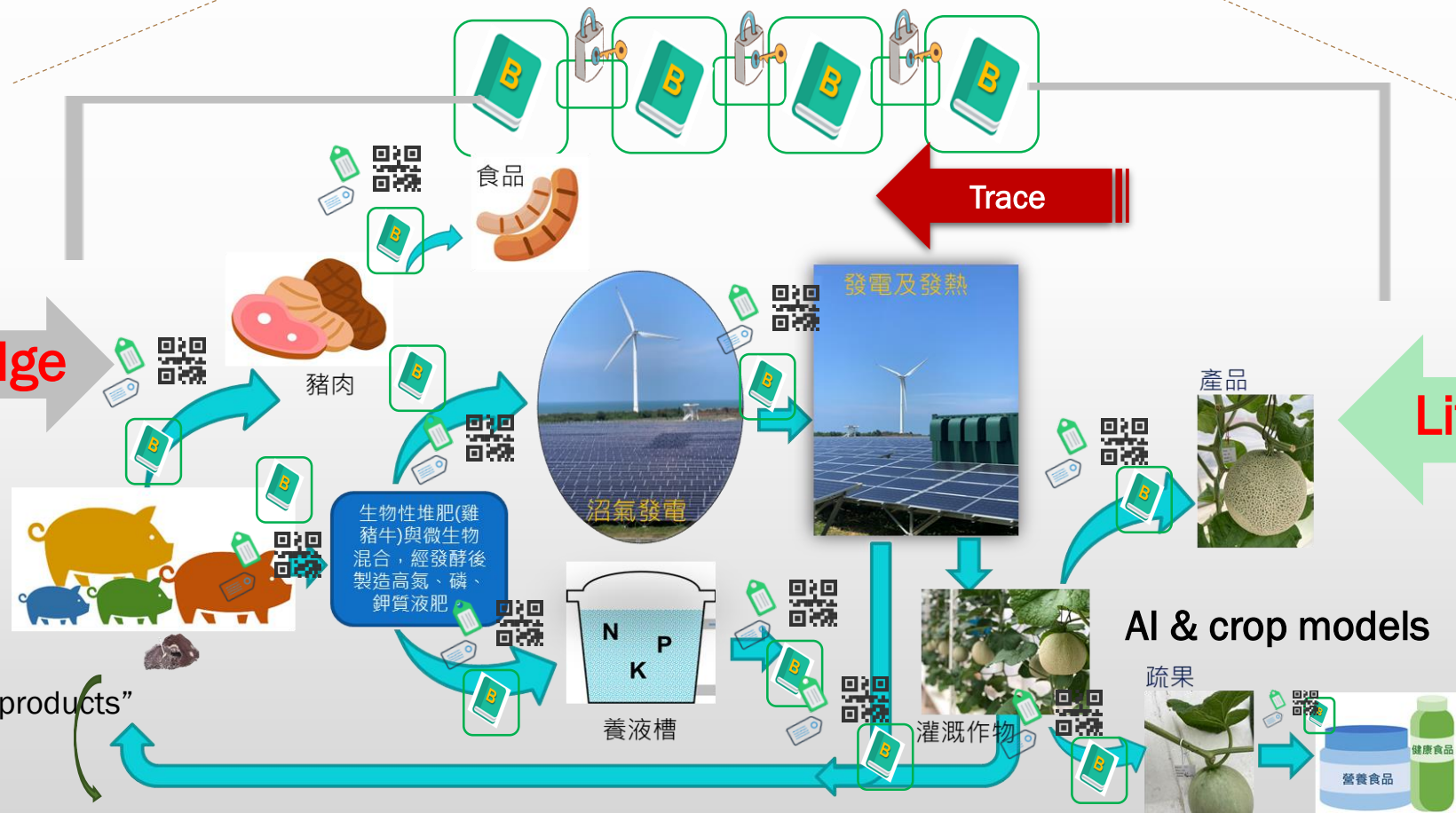


Safety

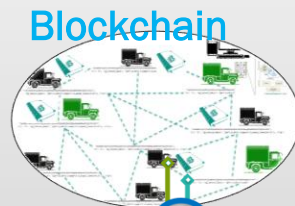
With Knowledge



Knowledge related to "products"



Inquire



Blockchain

Traceability

生物資材

含綠原酸、沒食子酸、鞣花酸、槲皮素、山柰酚、兒茶素、丁香油酚

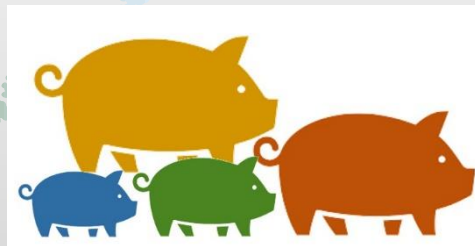
食品生產流程

➤ 豬隻屠宰流程

- ✓ 豬隻經過檢疫，致昏，放血，洗豬，去毛，剝皮，取出內臟，衛生檢查後稱重分級即可進行鮮肉販售。

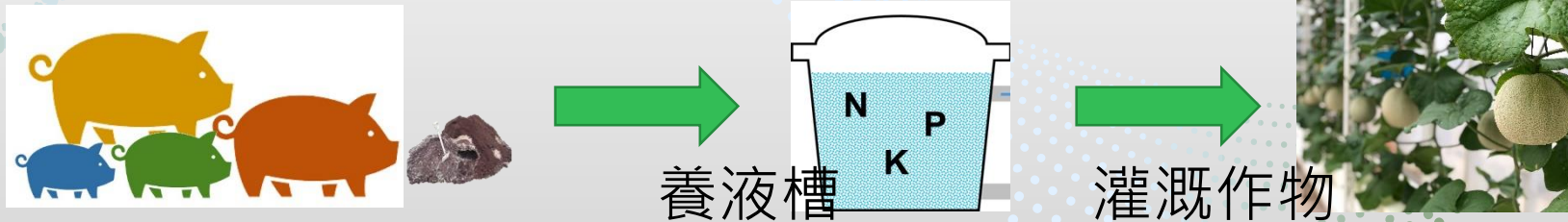
➤ 食品製作(以香腸為例)

- ✓ 豬肉經絞碎後醃製，再經灌腸分節，最後經在陰涼通風處晾曬數天即可進行烹煮食用。



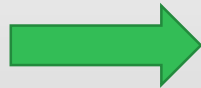
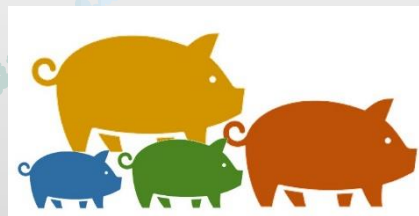
生物性肥料的製程

- 禽畜糞運送至堆肥場後，在有頂棚的堆積場舍與調整材予以混合，調整水分含量及碳氮比後置入醱酵設施內以進行醱酵。
- 在整個堆肥化過程中，係利用不同分解特性的微生物接替擔負分解的工作，最後將有機物分解後進行攪動達到腐熟階段。
- 生物性堆肥經醱酵後製造高氮、磷、鉀液肥。
- 生物資材。

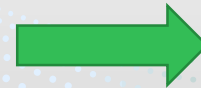


沼氣發電

- 因畜禽糞尿屬有機物，除含有大量氮與磷是作物生長所需之養分外，所含的碳與氫也是產製生質能源之最佳原料。
- 畜禽糞尿經厭氧處理，並去除腐蝕氣體硫化氫後，可生產沼氣，沼氣經脫水處理後以儲氣設備進行儲存，即可在發電過程中提供穩定的壓力，達到發電的最佳效能。



沼氣發電



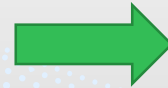
發電及發熱

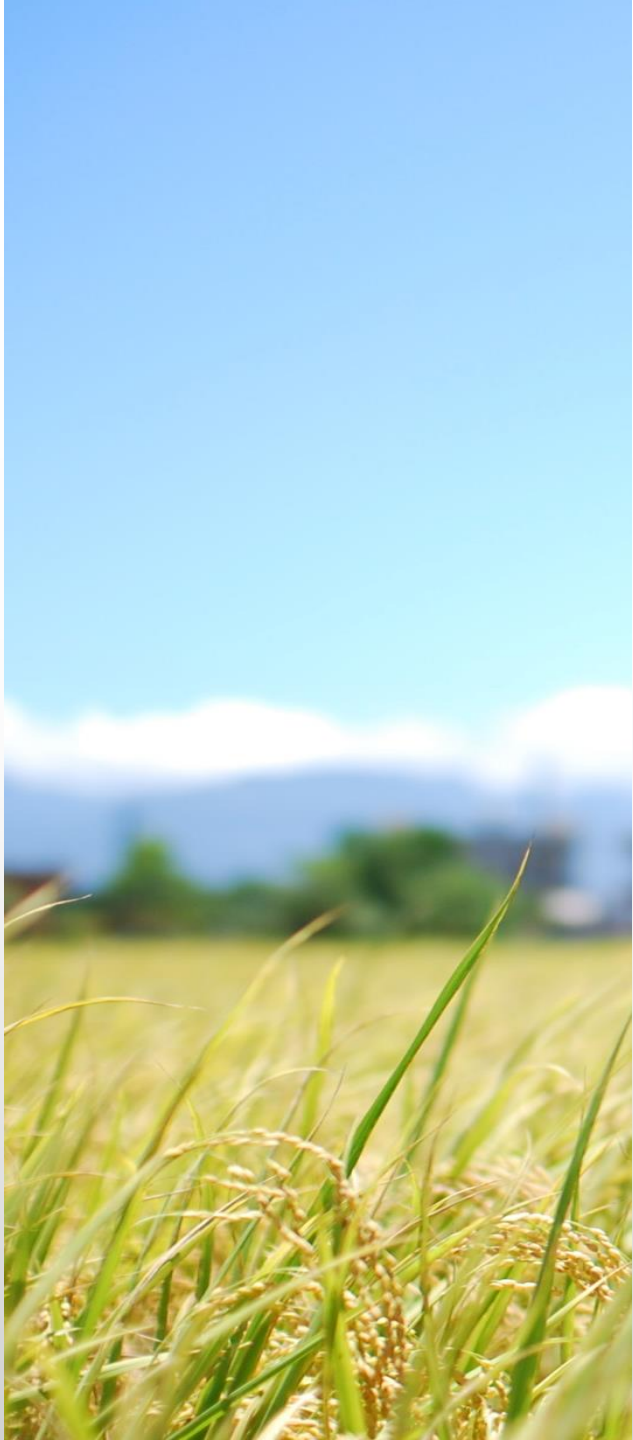
果物加工產品

- 作物經疏果過程採集之果物及果葉，可萃取得到綠原酸、沒食子酸、鞣花酸、槲皮素、山柰酚、兒茶素、丁香油酚等萃取物，可進行健康食品、化妝品及製藥及肥料飼料相關產品的製作。



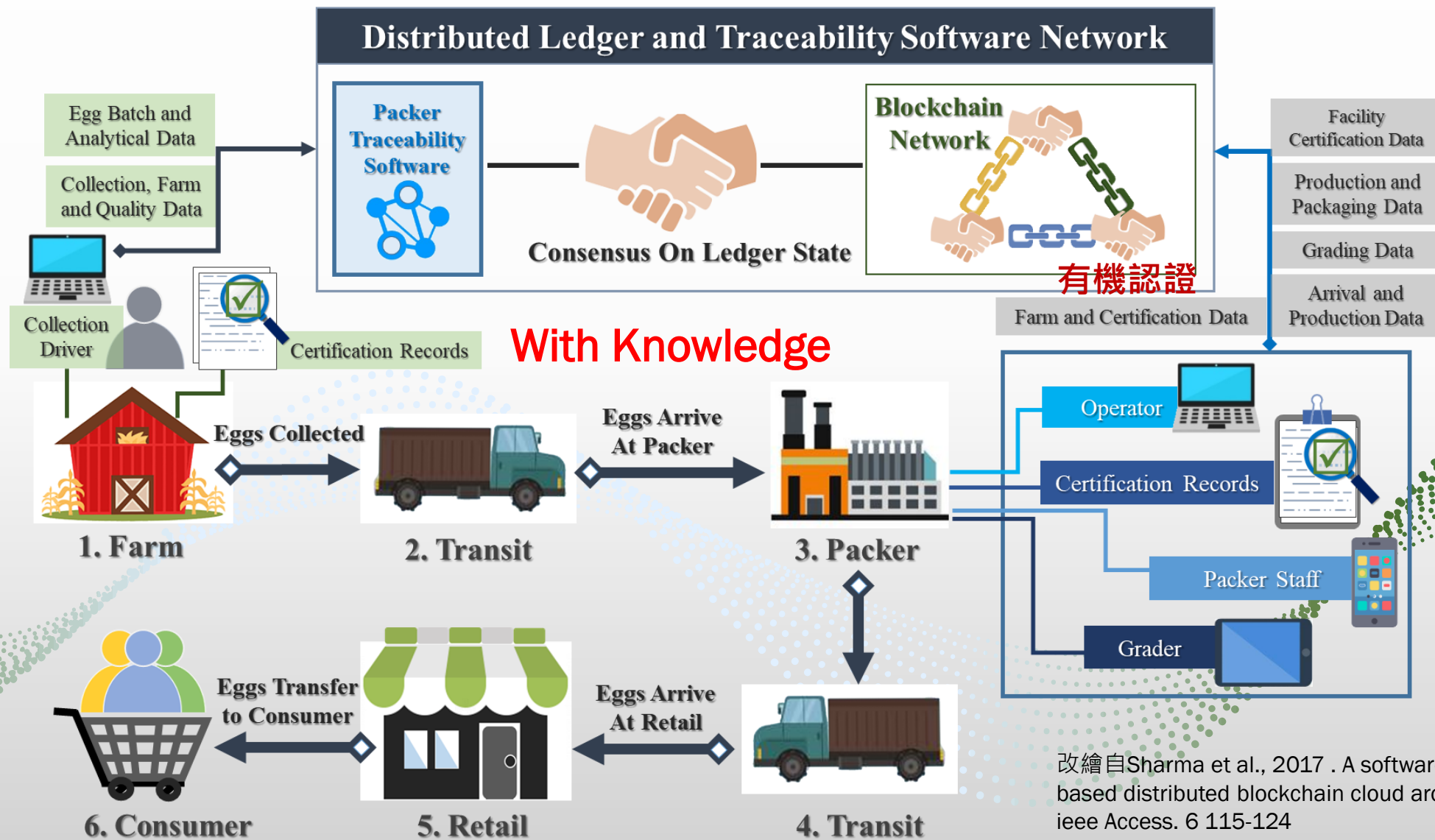
疏果





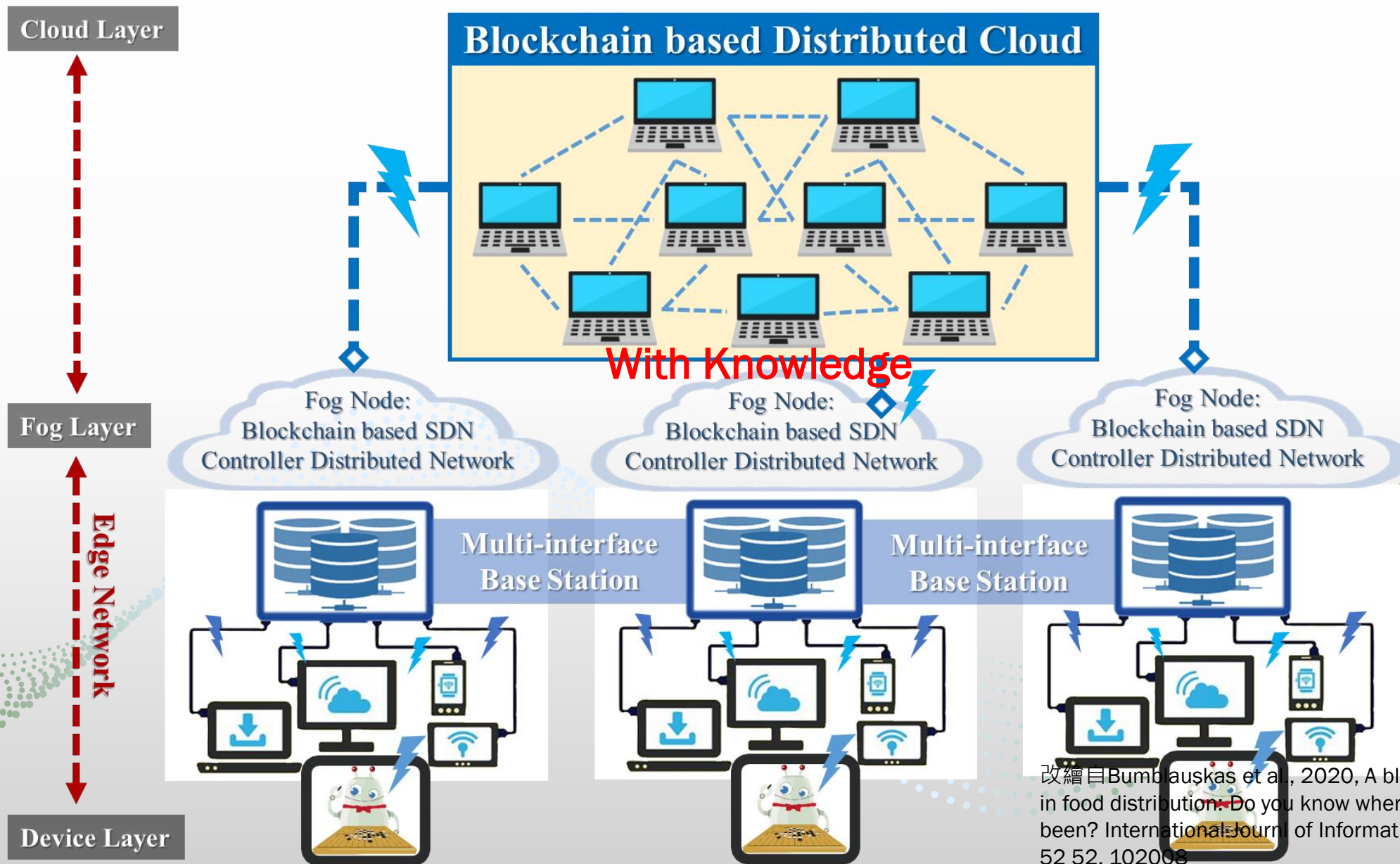
區塊鏈應用於農產品產銷之概念

區塊鏈與知識圖應用於農產品產銷之概念



改繪自Sharma et al., 2017 . A software defined fog node based distributed blockchain cloud architecture for IoT, iee Access. 6 115-124

區塊鏈與知識圖應用於農產品產銷之概念



改繪自Bumbauskas et al., 2020, A blockchain use case in food distribution. Do you know where your food has been? International Journal of Information Management, 52 52, 102008

IBM Food Trust

IBM 區塊鏈

Food Trust 功能 技術 為何選擇 Food Trust 互動式示範

IBM Food Trust。 嶄新的全球食品供應時代。

加入由生產者、供應商、製造商、零售商及其他方所組成的生態系統，為所有人建立更有智慧、更安全、更永續的食品系統。

 與我們的專家聯絡 →  瞭解 Food Trust 的運作方式



IBM Food Trust

全球各大連鎖超市紛加盟IBM Food Trust區塊鏈平台以追蹤食品供應鏈

陳明陽 2019-04-17

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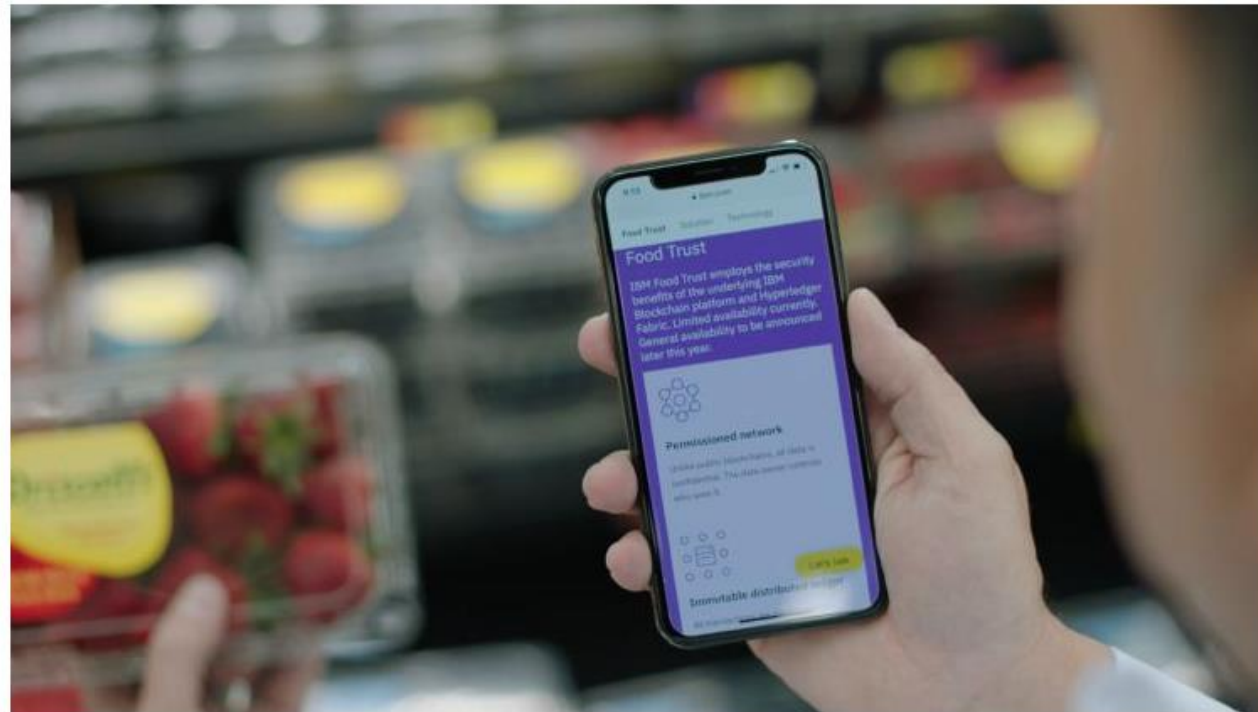
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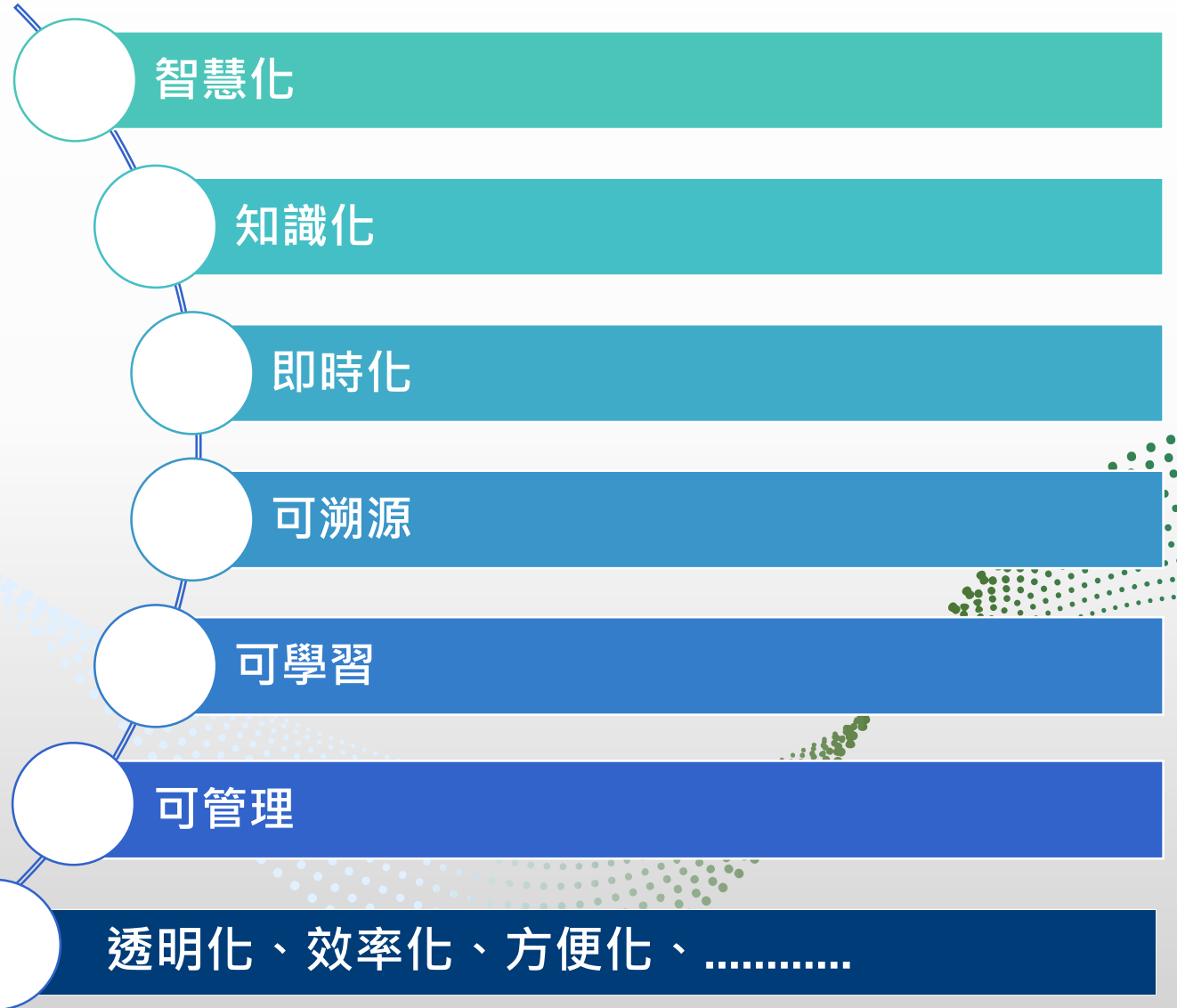
以IBM Food Trust區塊鏈平台支援食品溯源追蹤可讓顧客與廠商同時受惠。IBM

結語



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應用數位工具優化 農業產銷



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