講者簡介

Dr. Hiroshi Uehara (Japan)
Professor,
Faculty of Systems Science and Technology of Akita,Prefectural University
Vice President of Agricultural Data Collaboration Platform Consortium

Dr. Hiroshi Uehara 研究興趣為自機器學習型大數據中獲取知識，尤其關切自農業相關大數據中獲取知識。以知識獲取研究者的身分參與「環太平洋知識獲取工作坊」(Pacific Rim Knowledge Acquisition Workshop，PKAW 2019)的計劃委員會。與農業資料分析有關的近期研究活動包括：根據機器學習預測稻作生長狀況、農業新聞文本的非監督分群演算（ unsupervised clustering ）、農民對於社群網絡服務（ SNS ）評論的季節性變化分析等。此外亦研究自然語言處理演算法，如：隱藏式馬可夫模型（ hidden Markov model ）和潛在狄利克里分配（ latent Dirichlet allocatoin ）。

Dr. Hiroshi Uehara research interests are knowledge acquisition from big data based on machine learning technique. Especially acquiring knowledge from agricultural big data is of his main interests. As a researcher of knowledge acquisition, he is a program committee of Pacific Rim Knowledge Acquisition Workshop (PKAW 2019). Recent research activities concerning agricultural data analysis are prediction of rice crop growth based on machine learning, unsupervised clustering of agricultural news texts, and analysis of seasonal changes of farmers' comments on SNS etc. His research also includes algorithm of natural language processing, such as hidden Markov models and latent Dirichlet allocation.

QUALIFICATIONS

- 1999-2017: Vice president of NTT DOCOMO,INC.
- 2017-2019: Specially Appointed Professor of Keio University

PROFESSIONAL EXPERIENCE

- 2019: A project manager of data platform for exporting agricultural products in Smart Food Chain Consortium, under Strategic Innovation Promotion Program of the Cabinet Office.
- 2019: Guest Editor for the ITU Journal: ICT Discoveries special issue on AI and Agriculture
- 2019: Pacific Rim Knowledge Acquisition Workshop program committee

Information Service Platforms in Agriculture

- Services and the architecture toward Smart Food Chain -

Aug.22th 2019

Strategic Innovation Promotion Program

Hiroshi Uehara

(Professor, Akita Prefectural University)

Big Data Becomes Common Word

- Demonstrates remarkable successful
- Applications concern knowledge acquisitions

Big data of Play records

Big data of Medical paper
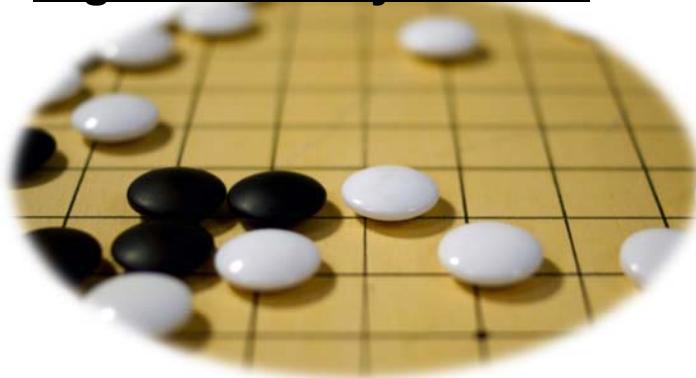
Acquiring Knowledge to overcome superior game players

Acquiring Knowledge to automatic diagnoses

農業資訊服務平台

-邁向智能食品鏈的服務與架構-

2019年8月22日

策略創新促進計畫

Hiroshi Uehara

秋田縣立大學教授

大數據已成為常用詞

- 顯示非常成功
- 涉及知識獲取的應用

棋局記錄的大數據
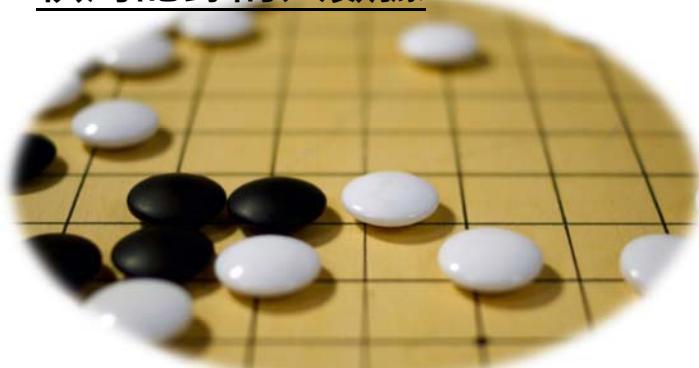
醫學論文的大數據

獲取知識以打敗優秀的遊戲玩家

獲取知識以自動診斷

Expectations for Agricultural Big Data in Japan (background)

Rapid declining farmers' population

1. Rapid expansion of deserted cultivated lands
2. Loss of experience and implicit knowledge

Area of deserted cultivated lands amounts well over **1%** of land area of Japan

Big data ! Knowledge for overcoming the situation

We need Integrated Agricultural Data Platform!

Prime minister's statement on the Future Investment Strategy 2017 for realizing society 5.0.

Decision at Cabinet meeting (summery)

"We should establish agricultural data platform '**Agricultural Data Collaboration Platform**' within this year(2017)."

對日本農業大數據的期望（背景）

農民人口迅速減少

1. 荒蕪耕地迅速擴張
2. 經驗和隱性知識消逝

荒蕪耕地的面積超過日本陸地面積的1%

大數據！克服困境的知識

我們需要整合的農業數據平台！

首相在2017未來投資策略聲明實現社會5.0。

內閣會議的決定

摘要

「我們應該在今年(2017年)建立
『農業數據協作平台』」

However, important issues exist in agricultural big data


Issues of Agricultural Big data(1)

1. Widely scattered across organizations and locations
2. Data formats are not well organized

locations

Market data

Soil data

organizations

Breed data

Climate data
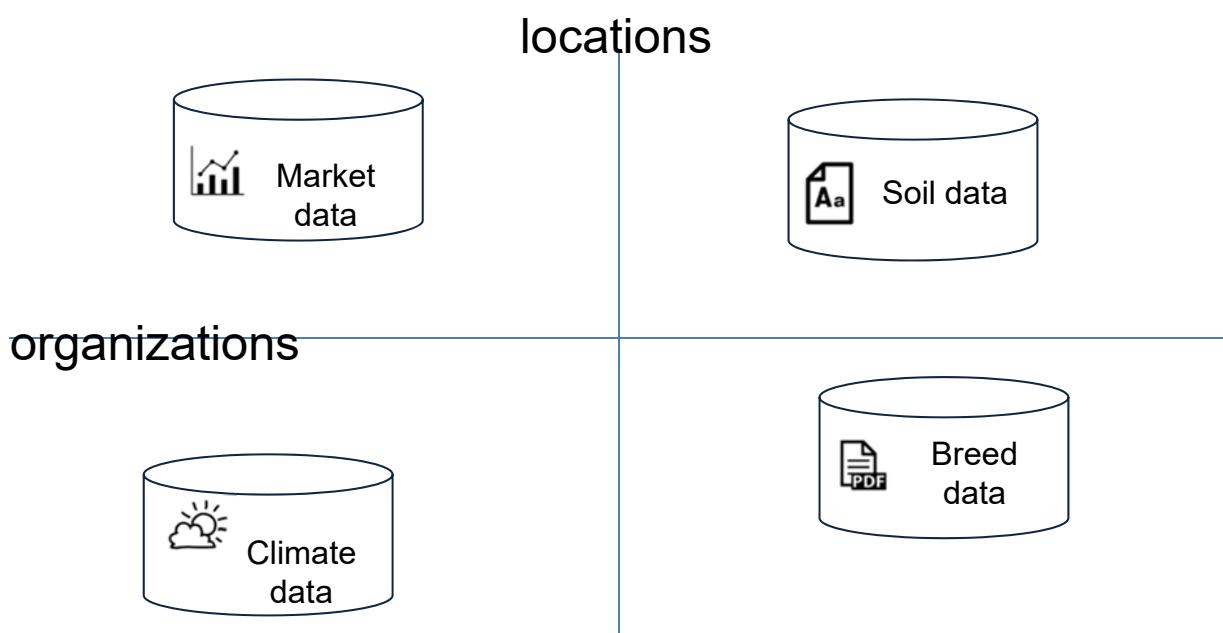
然而，農業大數據存在重要問題

農業大數據問題（1）

1. 廣泛分散在各個組織和地點
2. 數據格式無條理
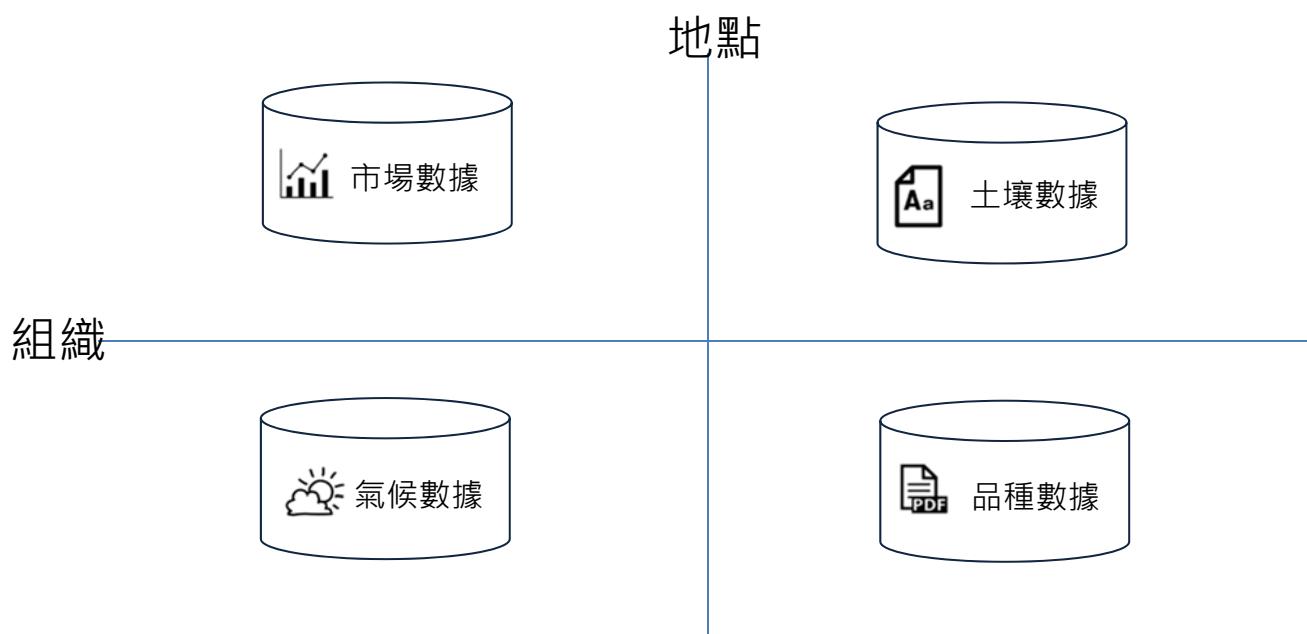
Issues of Agricultural Big data(2)

Farmers do not have much experience how they use agricultural data
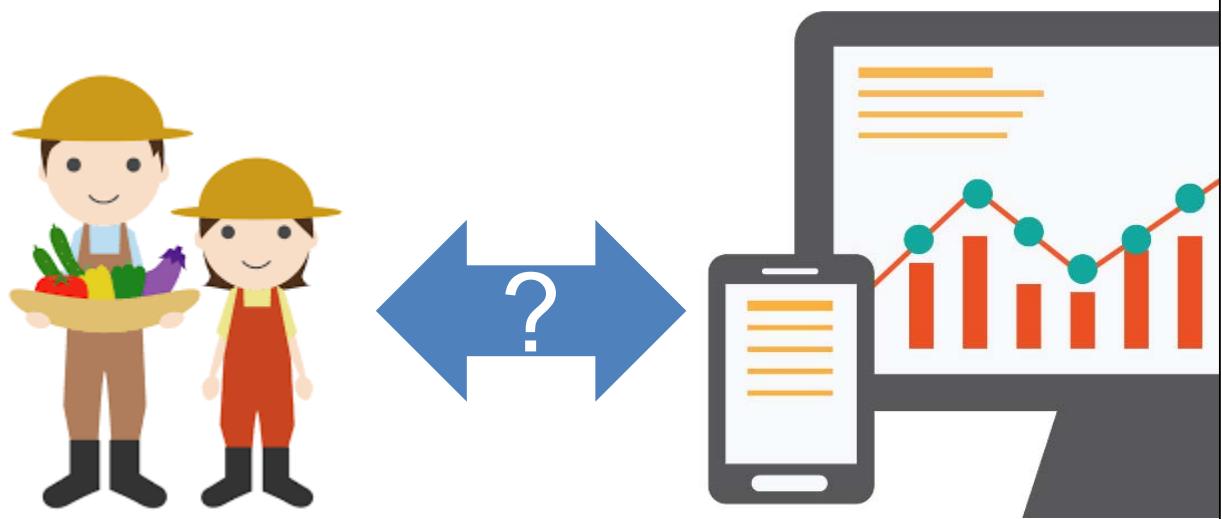
Pre-matured industry for data application

Agricultural Big Data Development Project has been started since 2017

## "Agricultural Data Collaboration Platform"
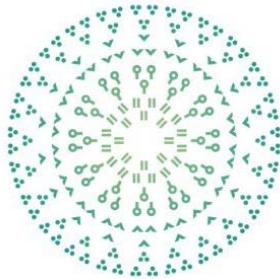
Logo implies

WA + AGRI

WA = Harmony in Japanese
AGRI = Agriculture

WAGRI

農業大數據問題（2）

農民對使用農業數據沒有太多經驗
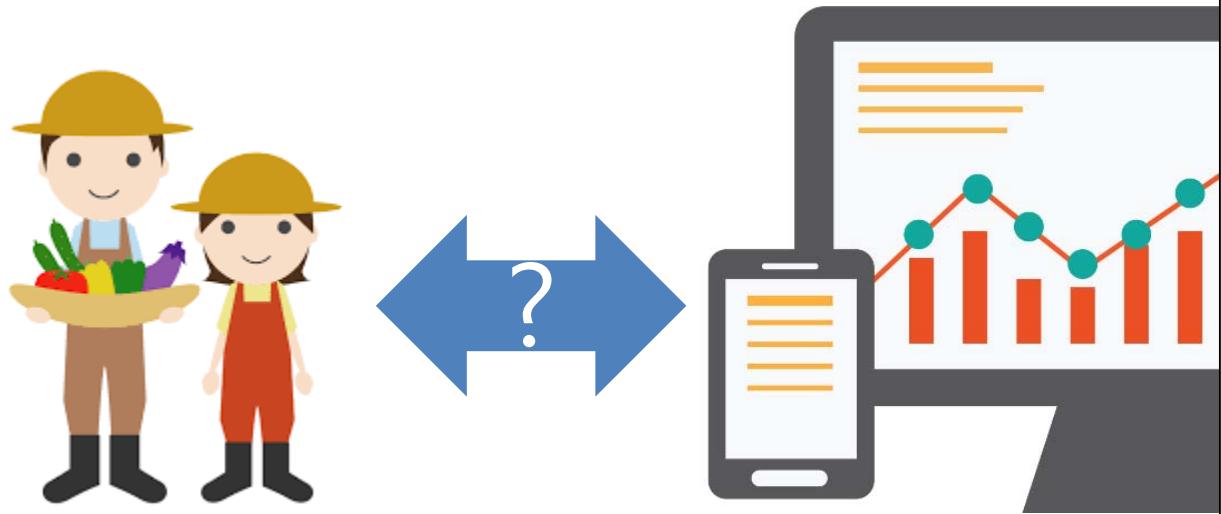
未成熟的數據應用產業

農業大數據發展計畫自2017年開始實施

「農業數據協作平台」
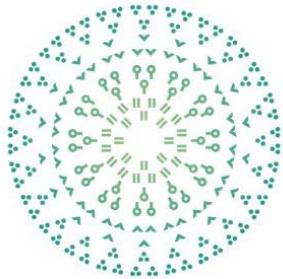
WAGRI

標誌由 WA + AGRI 組成

WA = 和諧的日語
AGRI = 農業

Membership of WAGRI development project

Chairman : Atsushi Shinjo
(Professor, Keio University)

- Founder of this project

Vice President : Hiroshi Uehara
(Professor, Keio University)

Private companies etc. : aprox. 20 companies
 ・ Major Agriculture Machinery companies,
 ・ Telecommunication companies,
 ・ IT vendors etc.

Agricultural Data Collaboration Platform Consortium

Established as of 22nd Aug. 2017

Open consortium for collecting opinions

Over **300** Organizations have been joined

The largest big data consortium in Japan

WAGRI發展計畫的成員

主席：Atsushi Shinjo
（慶應義塾大學教授）

- 計畫創辦人

副主席：Hiroshi Uehara
（慶應義塾大學教授）

私人企業：約20間公司
　·主要的農業機械公司
　·電信公司
　·IT供應商等

農業數據協作平台聯盟

成立於2017年8月22日

開放聯盟收集意見

300多個組織已加入

日本最大的大數據聯盟
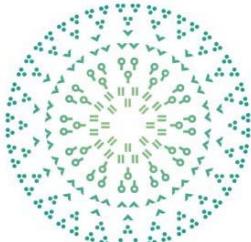
Data Structure of WAGRI

How big is agricultural data ?

example : Soil Classification

Just a few square ㎢ of an area

➡ 800 pairs of lat, lng!

[{'PrefectureCode': '5', 'SoilName': 'Gray Lowland Soil', 'SoilLargeCode': 'F2', 'SoilMiddleCode': 'F2', 'SoilSmallCode': 'F2', 'Polygons': [{'Coordinates': [{'Latitude': 39.94785327326453, 'Longitude': 139.94917032719306}, {'Latitude': 39.949492549091346, 'Longitude': 139.94972935120717}, {'Latitude': 39.95501187166544, 'Longitude': 139.95837164416596}, {'Latitude': 39.969037792875056, 'Longitude': 139.9794768313014}, {'Latitude': 39.98408389827826, 'Longitude': 140.00188628703512}, {'Latitude': 39.98971239136062, 'Longitude': 140.0109013059738

# WAGRI 數據結構

WAGRI

農業數據有多大？

例如：土壤分類

複雜形狀的小多邊形

Mitane

[{'Prefect...   ...eCode':
'F2', 'SoilI...   ...ordinates':
[{'Latitud...   ...806},
{'Latitude...   ...717},
{'Latitude...   ...96},
{'Latitude...   ...14},
{'Latitude...   ...12},
{'Latitude...   ...8

我們需要大量的多邊形來覆蓋日本所有地方

Oga Quasi National Park

Oga

Unprecedented Big Data

- Small polygons are major structure of WAGRI
- Small polygons can express any kinds of agricultural data

Farm Lands

Micro Climates

Growing Conditions

Soil Types
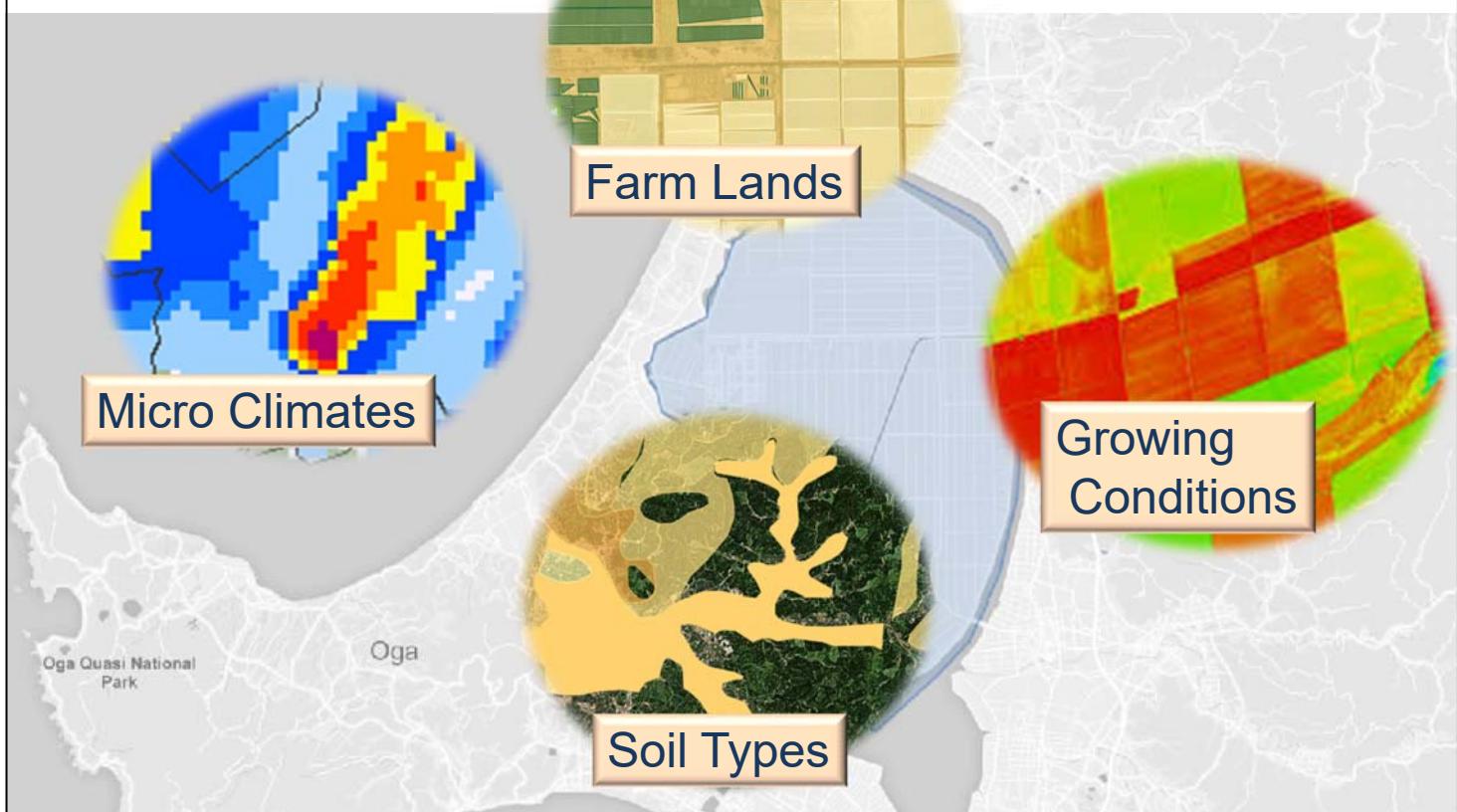
25 kinds of data are now implemented

■Maser data   ■Polygon data   ■Prediction models

Contents	Providers
Master of Fertilizer	Food and Agricultural Materials Inspection Center
Master of Agrochemicals	Food and Agricultural Materials Inspection Center
Aerial Photographic Map	NTT GEOSPACE CORPORATION
Farm Land Polygons	Ministry of Agriculture、Forestry and Fisheries
Agricultural Water Channels	Ministry of Agriculture、Forestry and Fisheries
Micro Climate （1 km mesh grid）	HALEX CORPORATION
Micro Climate （1 km mesh grid）	Life Business Weather Inc.
Prediction of Growth Stage of Crops	Vision Tech inc.
Soil Classification	National Agriculture and Food Research Organization

史無前例的大數據

- 小多邊形是WAGRI的主要結構
- 小多邊形可以表達任何種類的農業數據
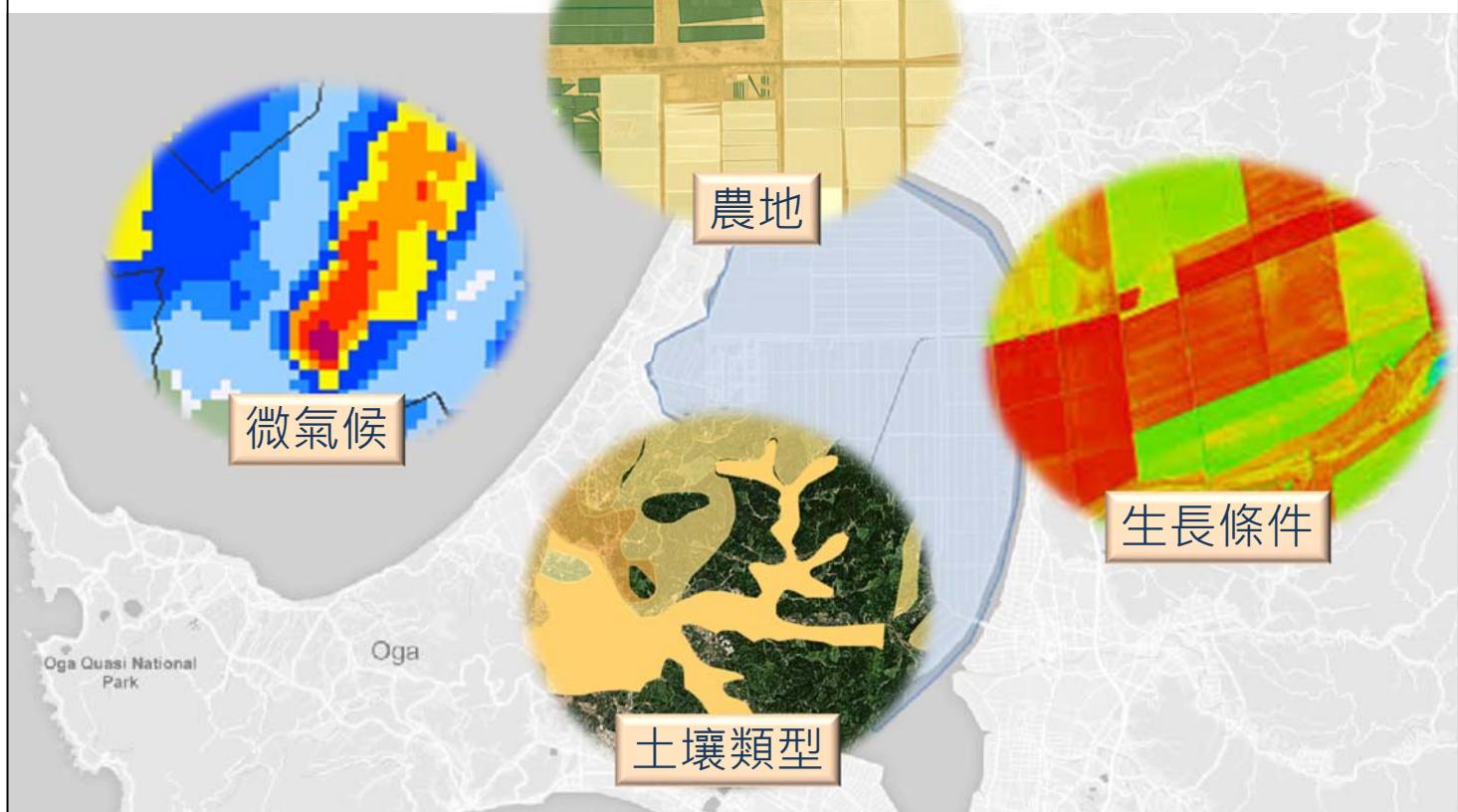
現有25種數據

■主要數據　■多邊型數據　■預測模型

內容	供應者
主要的肥料	Food and Agricultural Materials Inspection Center
主要的農業化學物質	Food and Agricultural Materials Inspection Center
航空攝影地圖	NTT GEOSPACE CORPORATION
農地多邊形	Ministry of Agriculture、Forestry and Fisheries
農業渠道	Ministry of Agriculture、Forestry and Fisheries
微氣候 （１km網格）	HALEX CORPORATION
微氣候 （１km網格）	Life Business Weather Inc.
作物生長階段預測	Vision Tech inc.
土壤分類	National Agriculture and Food Research Organization

How Users Retrieve Data ?

- All the data can be retrieved through API
- APIs are provided as unified formats

API/Public/soil/Get?lat={lat}&lng={lng}

Name of API Object   action   parameters

Request for specifying data

WAGRI API !

WAGRI as a cloud service

Relevant data

Just 3 Codes are Sufficient !

3 codes create any of request for WAGRI!

Example : Python codes

headers = {authentication information}

Request = urllib.request.Request('https://api.wagri.net/
    API/{parameters for data request}',headers=headers)
response = urllib.request.urlopen(request)

用戶如何檢索數據？

- 所有數據都可用API檢索
- API提供統一格式

API/Public/soil/Get?lat={lat}&lng={lng}

API物件名稱　　　行動　　　參數

請求指定數據

相關數據

WAGRI API！

WAGRI作為一個
雲端服務
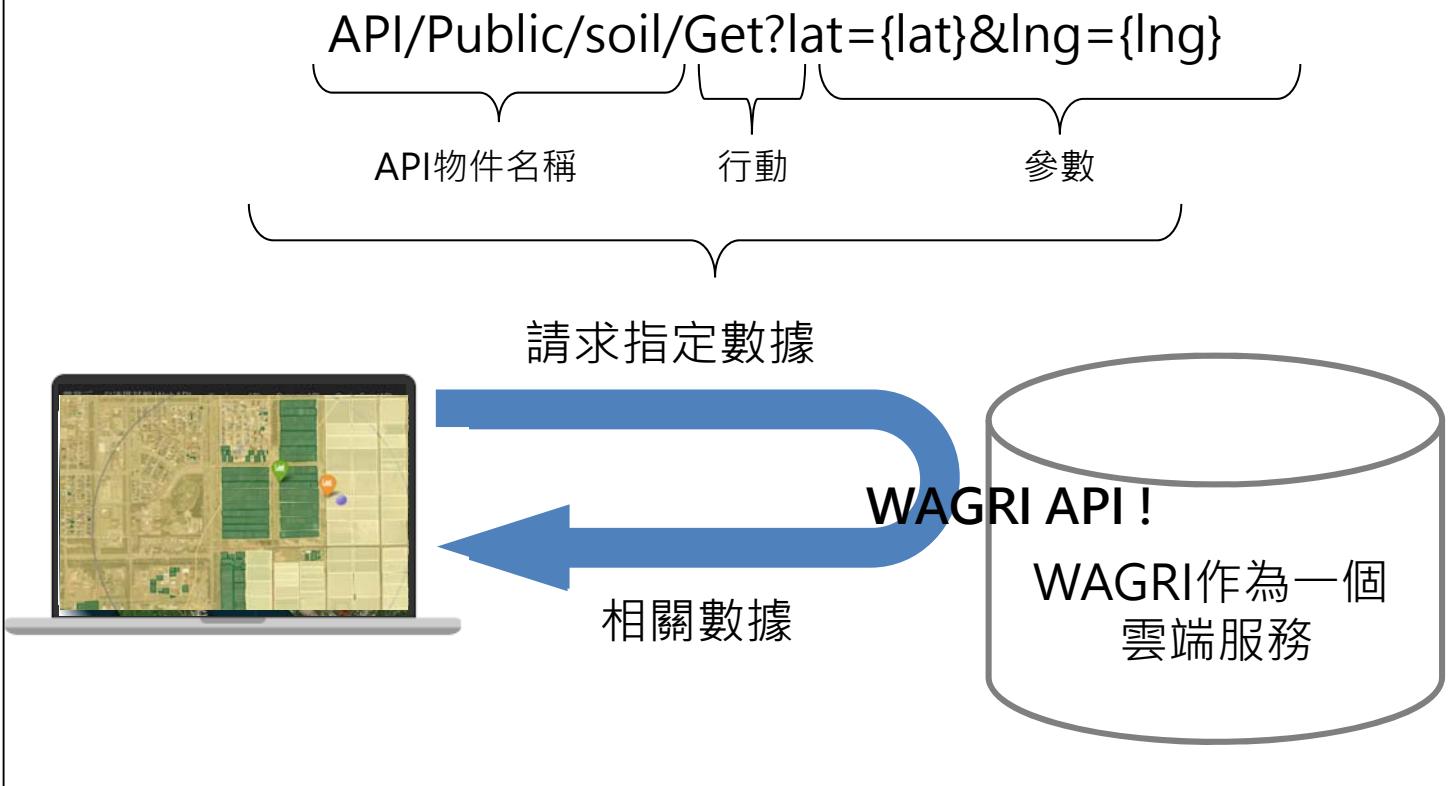
只需3個程式碼即可！

3個程式碼構成WAGRI的任何請求！

範例：Python 程式碼

```
headers = {authentication information}

Request = urllib.request.Request('https://api.wagri.net/
    API/{parameters for data request}',headers=headers)
response = urllib.request.urlopen(request)
```

Gaining Good Performance for Data Retrieval
Zooming out

- Multiple polygons can be depicted on a normal browser
- Polygons are fully zoomable

Zooming in
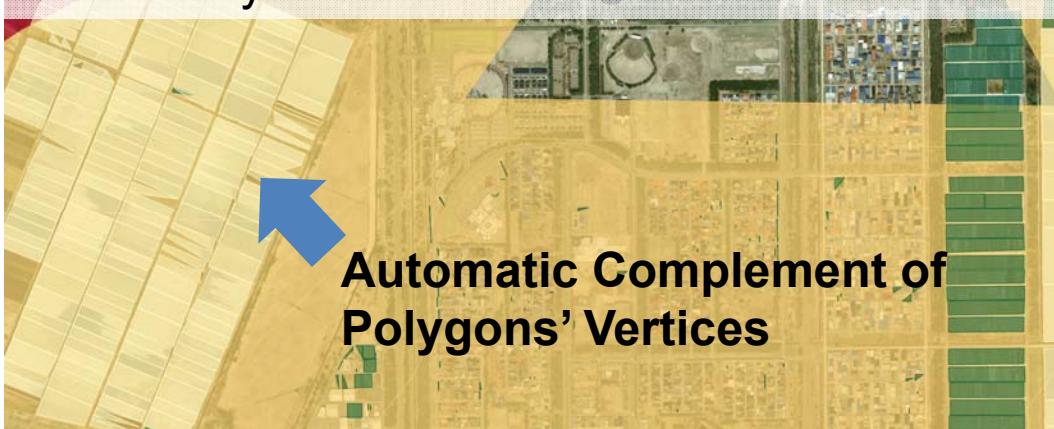
Automatic Complement of Polygons' Vertices

Applications

取得良好的數據檢索性能
縮小

縮小

- 可以在普通瀏覽器上描繪多個多邊形
- 多邊形是完全可縮放的   放大

多邊形頂點自動補碼

應用

(1) Prediction of Crop Growth

Mathematical Model of Crop Growth

S shape curve implies interesting characteristics of crop growth

Daily growth rate

Example :
Growth reaction is nonlinear
 to temperature

$$DVR = \frac{1}{G} \times \frac{1}{1 + \exp\{-A(T - T_h)\}}$$

G, A, T_h
 $: parameters\ to\ be\ estimated$

T

$: daily\ tempratere$

T_h:Threshold

T(daily temperature)
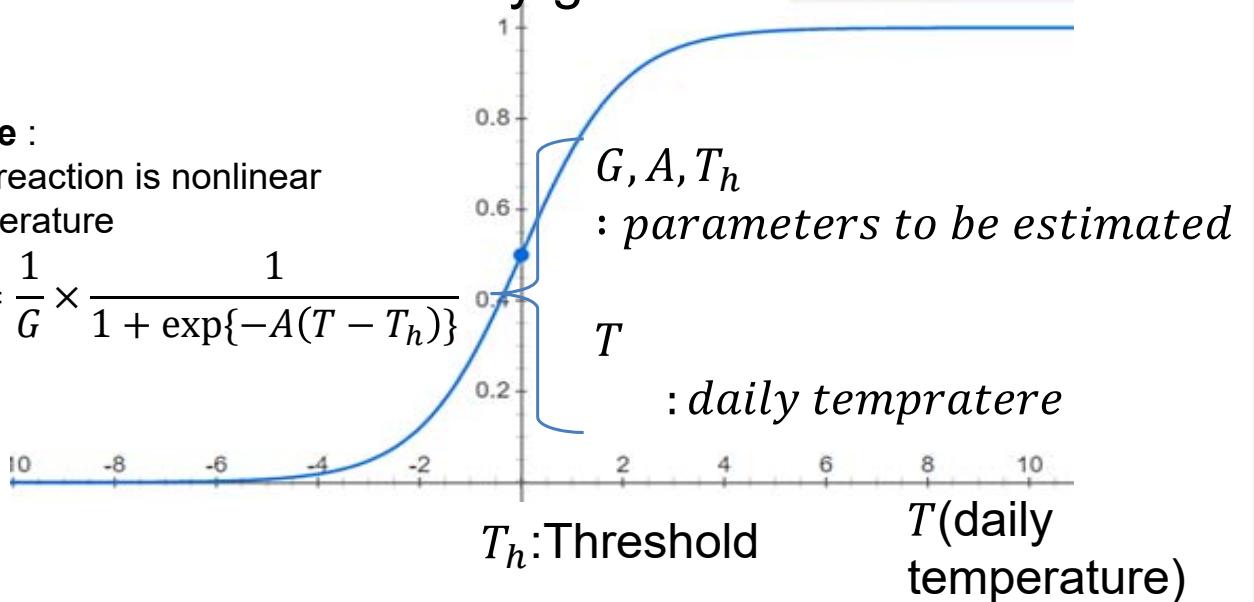
（１）作物生長預測

作物生長數學模型

S形曲線意味著作物生長的有趣特徵

每日生長率

範例：
生長反應與溫度呈現非線性關係

$$DVR = \frac{1}{G} \times \frac{1}{1 + \exp\{-A(T - T_h)\}}$$

G, A, T_h：欲估測的參數

T：每日溫度

T_h：閾值

T(每日溫度)
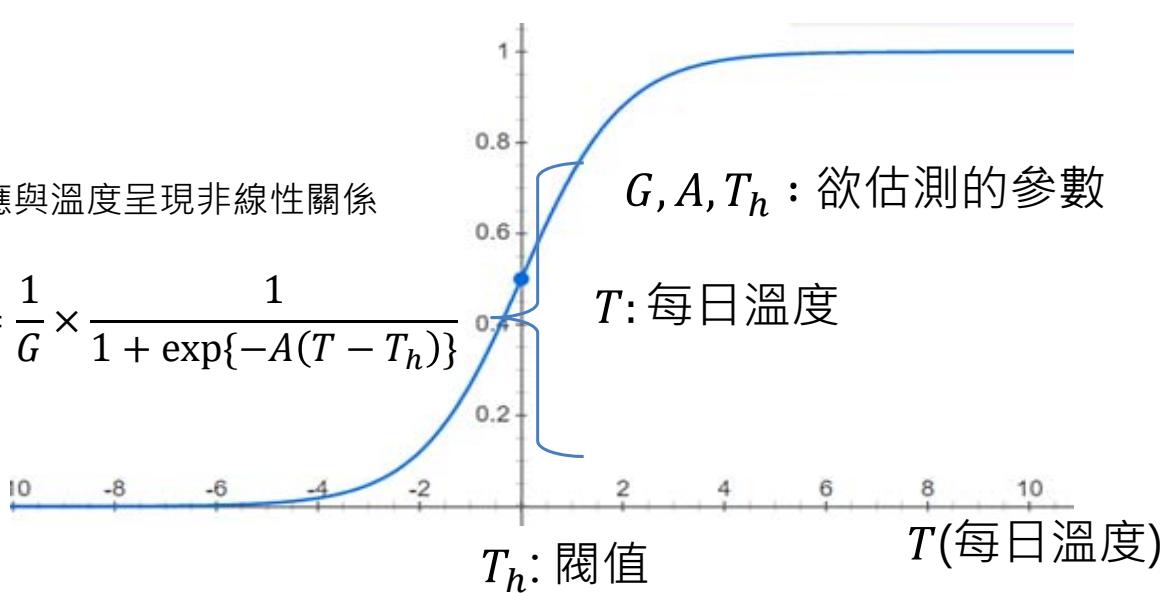
The value of T_h is different by category of crops

T_h =? ℃
rice crop

T_h =? ℃
wheat

T_h =? ℃
potato
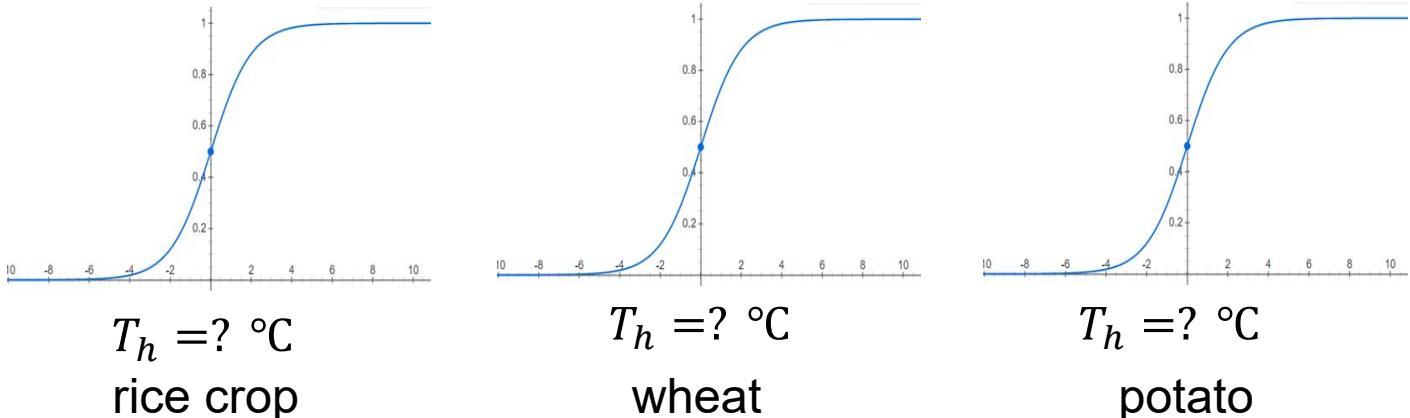
T_h is unknown, and should be estimated in order for the predictions

Category of Crops WAGRI can predict

WAGRI has learned $T_h s$ based on records of crop growth

Category of Crops	Predictable Growing Stage
Rice crop	Heading date, period of maturity, period of harvesting
Soy bean	Sprouting date, heading date, period of maturity
wheat	Sprouting date, heading date, period of maturity
lettuce	period of harvesting

Crop growth prediction is possible

不同種類的作物 T_h 值不同

T_h =? ℃
稻米

T_h =? ℃
小麥

T_h =? ℃
馬鈴薯

T_h 未知，但需估測才能做預測
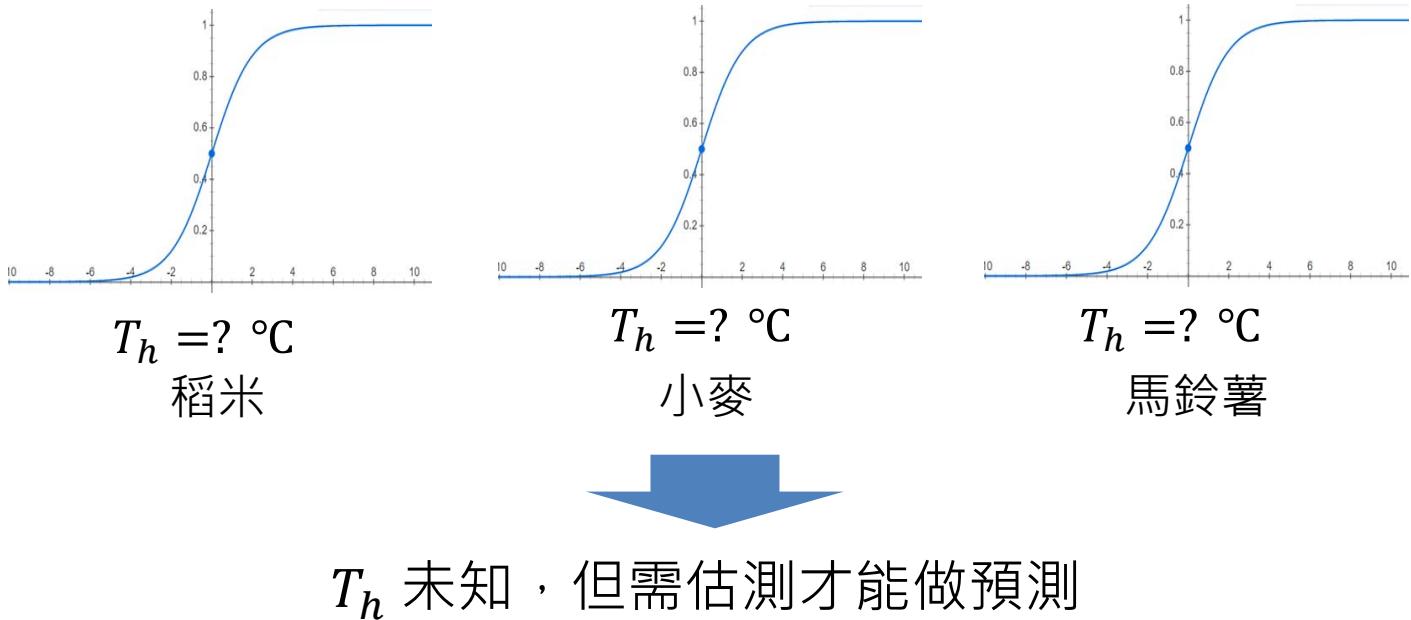
WAGRI可以預測作物種類

WAGRI根據作物生長記錄學習到 $T_h s$

| 作物種類	可預測的生長階段
稻米	抽穗日、成熟期、收穫期
黃豆	發芽日、抽穗日、成熟期
小麥	發芽日、抽穗日、成熟期
萵苣	收穫期

作物生長預測是可能的

API for Crop Growth Prediction

Request Message for prediction
Parameters:
 - category of crops
 - location of cropping

WAGRI

Micro climate

**Growth Prediction**

Result of Prediction

$$DVR = \frac{1}{G} \times \frac{1}{1 + \exp\{-A(T - T_h)\}}$$

DVR
(Daily growth rate)

Learned parameters

---
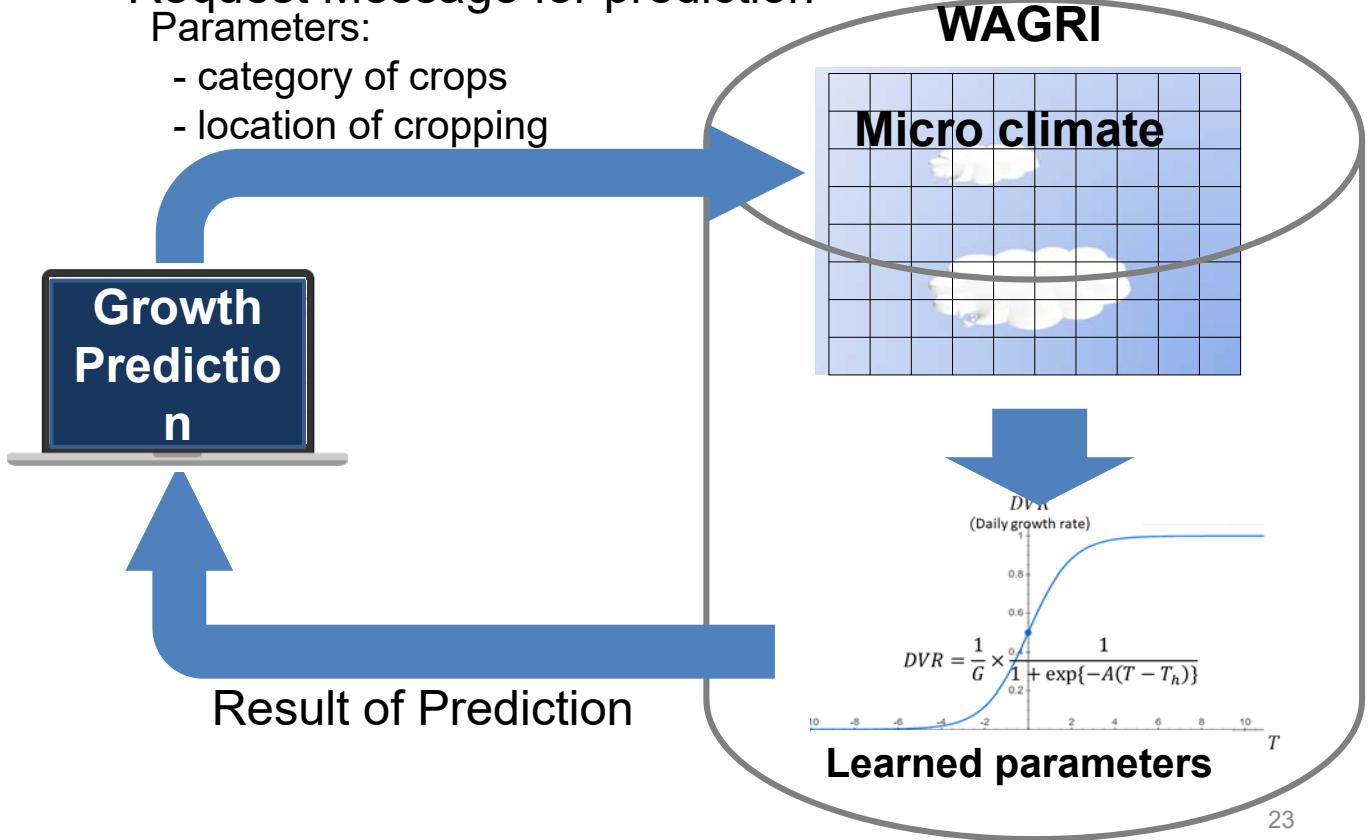
(2)Supporting Large Scale Farming

作物生長預測的API

請求訊息進行預測
　參數：
　　- 作物種類
　　- 作物地點

生長
預測

WAGRI

微氣候

$$DVR = \frac{1}{G} \times \frac{1}{1 + \exp\{-A(T - T_h)\}}$$

DVR
(Daily growth rate)

學習到的參數

預測結果

23

（2）支持大規模農業

24
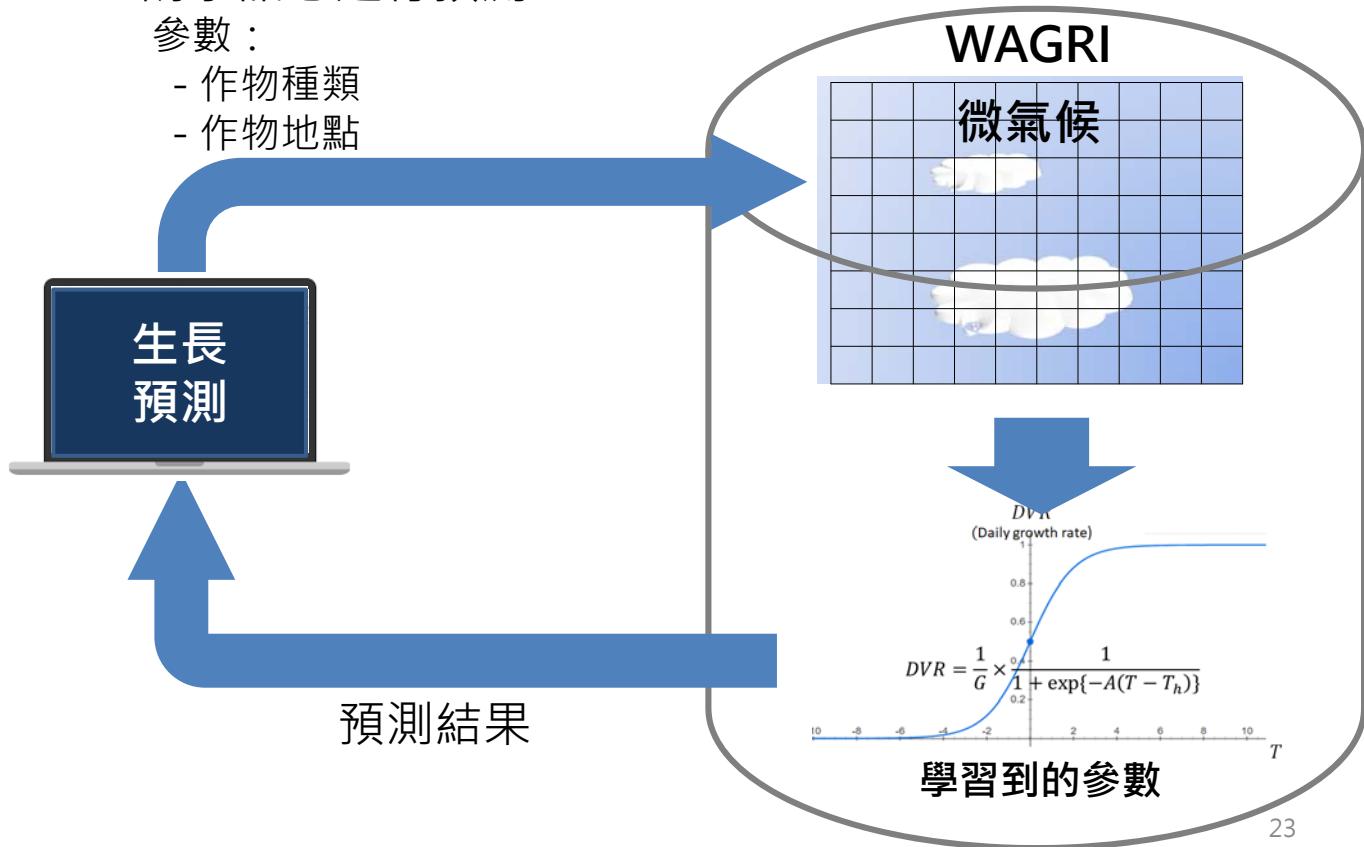
Emergence of Large Scale Farming

●Collection of distributed small deserted lands amounts to **thousands** of farm lands!

20a

Distance between neighboring farm lands is 2-3 km

30a

When and who do what in where in each field?

APIs for Large Scale Distributed Farming

Multiple APIs cooperatively work for managing data of scattered cultivation.

Owner

| API/Private/Farmer/ |
| Farming Corporation |

| API/Private/Field/ |
| Farm Field |

| API/Private/Staff/ |
| Farming Staff |

| API/Private/Planting/ |
| Cropping Information |

| API/Private/Cultivation |
| Cultivation Work |
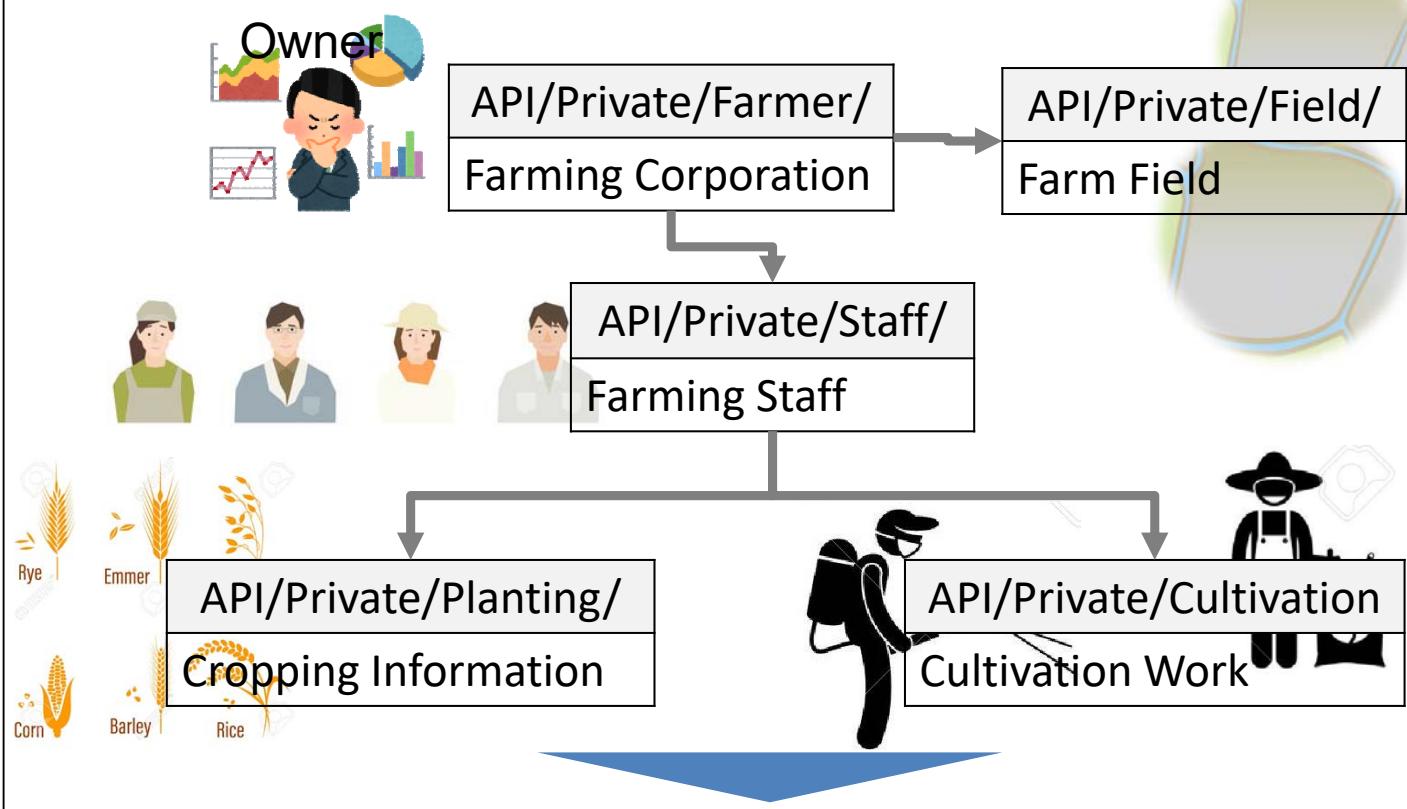
They are not APIs only for data retrieval

大規模農業的出現

- 收集分散的小荒地
  相當於數以千計的農田！

20a

鄰近農場之間的距離為2-3公里

30a

何時、何者、在哪塊田做什麼？

用於大規模分散式農業的API

多個API協同工作，管理分散式耕作的數據。

所有人

| API/個人/農民/ 農業公司 | → | API/個人/田地/ 農田 |

API/個人/員工/ 農業人員

| API/個人/種植/ 作物訊息 | | API/個人/栽培 栽培工作 |

它們不是僅用於數據檢索的API
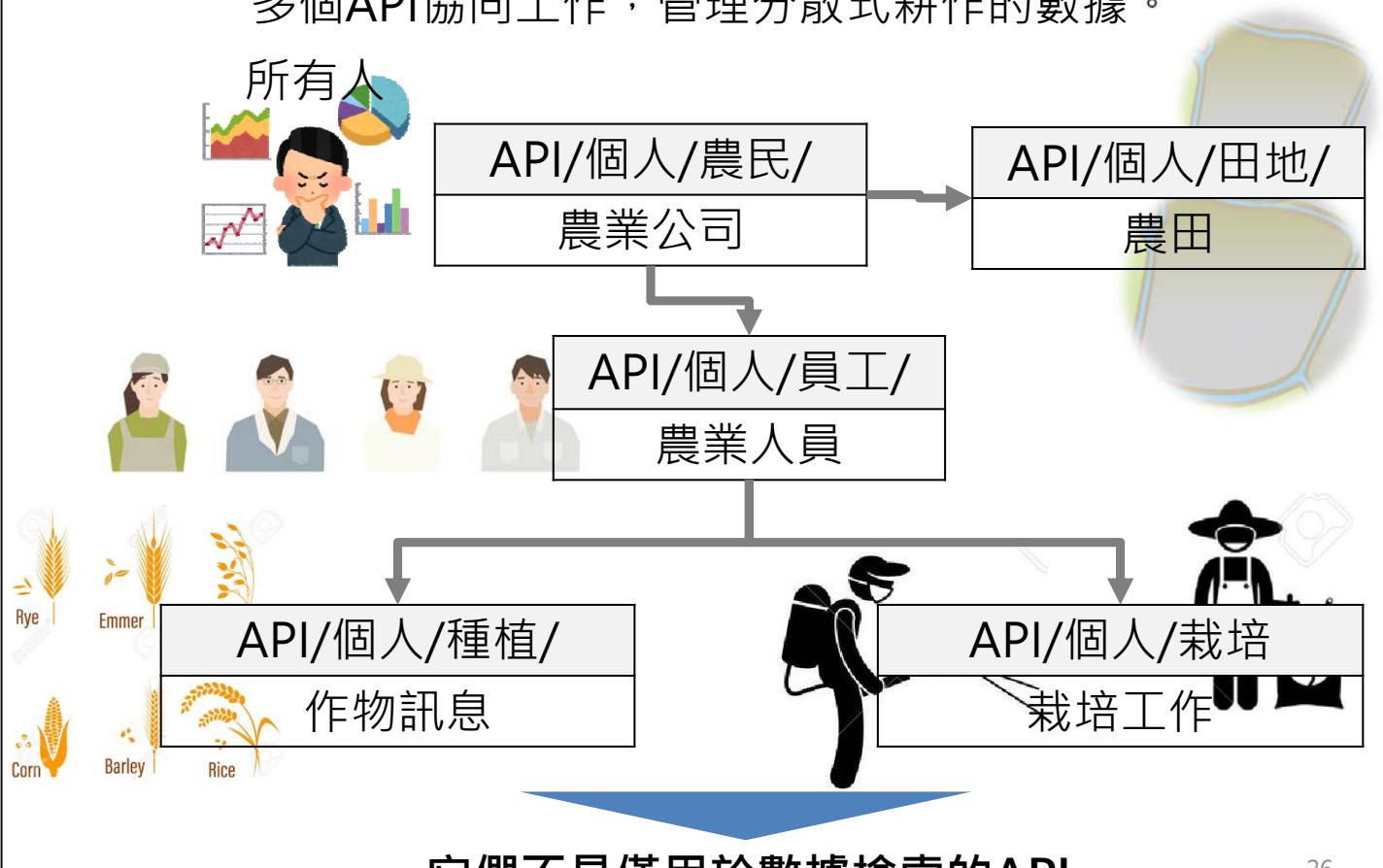
(3)User Defined API
~ Customizing API by Users Themselves

Accommodating Individual Farming Requirements

API/Private/Field/

Farm Field

Default data items

Field ID : 0001
Latitude : 30.1234
Longitude : 130.456

API/Private/Field/

Farm Field with Soil

Customized data items

Field ID : 0001
Latitude : 30.1234
Longitude : 130.456
Soil : Gray

e': '5', 'SoilName': 'Gray Lowland Soil
'F2', 'SoilMiddleCode': 'F2', 'SoilSmallC
ordinates': [{'Latitude': 39.94785327
94917032719306}, {'Latitude':
)1346, 'Longitude': 139.9497293512(
5501187166544, 'Longitude': 139.95
39037792875056, 'Longitude': 139.9
3408389827826, 'Longitude': 140.00
3971239136062, 'Longitude': 140.01

Soil Types

（３）用戶定義的API
～用戶自己制定API

適應個人農業需求

| API/個人/田地/ |
| 農田 |

預設數據項目：
農田ID：0001
緯度：30.1234
經度：130.456

| API/個人/田地/ |
| 有土壤的農田 |

客制化數據項目
農田ID：0001
緯度：30.1234
經度：130.456
土壤：灰色

e': '5', 'SoilName': 'Gray Lowland Soil
'F2', 'SoilMiddleCode': 'F2', 'SoilSmallC
ordinates': [{'Latitude': 39.94785327
94917032719306}, {'Latitude':
1346, 'Longitude': 139.94972935120
5501187166544, 'Longitude': 139.95
59037792875056, 'Longitude': 139.9
8408389827826, 'Longitude': 140.00
8971239136062, 'Longitude': 140.01

土壤類型

User Defined API

WAGRI enables to create users' original API by themselves

GUI for creating user defined API

name of API /API/individual/field_with_soil/

Defining name of API

Method type

Regist

POST

Regist

Data model

Field ID : 0001
Latitude : 30.1234
Longitude : 130.456
Soil : Gray

Defining data items

クエリ　Script　サンプルコード

```
{
    Execute: API/Public/soil/Get?lat&lng
}
```

Description of internal procedure

WAGRI as a Whole

summery

用戶定義的API

WAGRI可以自己建立用戶的原始API

用於建立用戶定義API的GUI

API名稱 /API/individual/field_with_soil/

Regist ▾

定義API的名稱

方法種類 POST ▾

數據模型

農田ID：0001
緯度：30.1234
經度：130.456
土壤：灰色

定義：數據項目

クエリ　Script　サンプルコード

```
{
  Execute: API/Public/soil/Get?lat&lng
}
```

內部程序的描述

WAGRI作為一個整體

摘要

WAGRI, Agricultural API

1. Agricultural Big data platform
   (good performance for data retrieval)
2. Knowledge acquisition(prediction etc.)
3. Data management
4. User defined API

Approx. 120 APIs are equipped

Enabling 120 APIs within 1.5 years

WAGRI architecture enables independent development

WAGRI's Architecture

Development of APIs

independent

Platform Development
Database Construction
Data processing
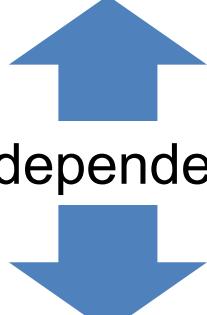
WAGRI、農業 API

1. 農業大數據平台
   （數據檢索性能良好）
2. 知識獲取（預測等）
3. 數據管理
4. 用戶定義的API

約配備120個API

在1.5年內啟用120個API

WAGRI架構實現了獨立開發

WAGRI架構

API開發

平台開發
資料庫架設
數據處理

獨立

Field Trials

Adapting modern farming style

Issues of Large Scale Farming

Multiple agricultural machines of different makers are mixed

【Current issues】

Data can not be shared between different makers

A Company's data

B Company's data

??

C company's data
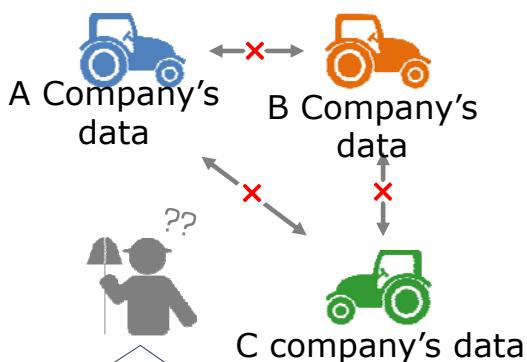
Operational data are separated

【Purpose of the Trial】

WAGRI provides with data sharing service
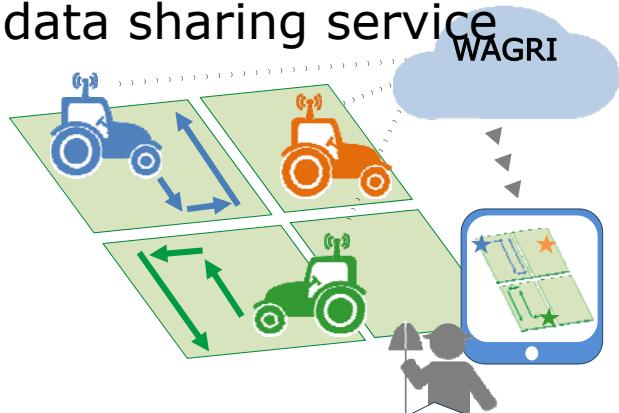
WAGRI

Enable integrated viewing of machinery operations

田間試驗

適應現代農業風格

大規模農業的問題

多台不同廠商製造的農業機械混合在一起

【目前的問題】

數據無法在不同製造商之間共享

A公司的數據　　B公司的數據

??

C公司的數據
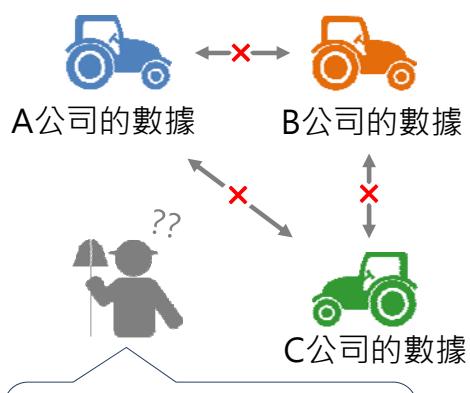
運營數據是分開的

【試驗目的】

WAGRI提供數據共享服務
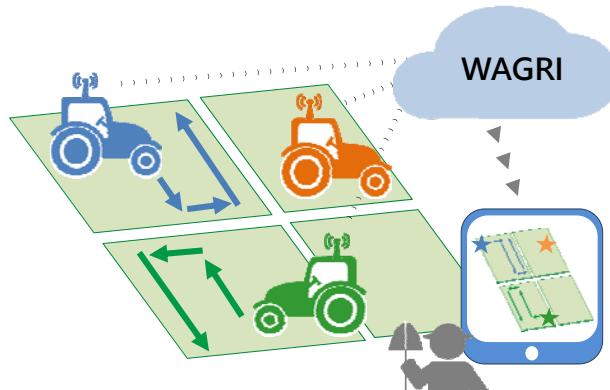
WAGRI

機械操作整合一起看

An Example of the Data Sharing Trial

Developing interfaces
Creating customized API

WAGRI
- Agricultural machinery companies
- ICT companies

収穫作業   ✕
オーナー： HNJ0021
機　種： EG53AF33
号　機： NECSI-102
開始日時： 2018-03-07 06:33:43
終了日時： 2018-03-07 06:34:25

Copyrights: NEC Solution Innovators, Ltd.
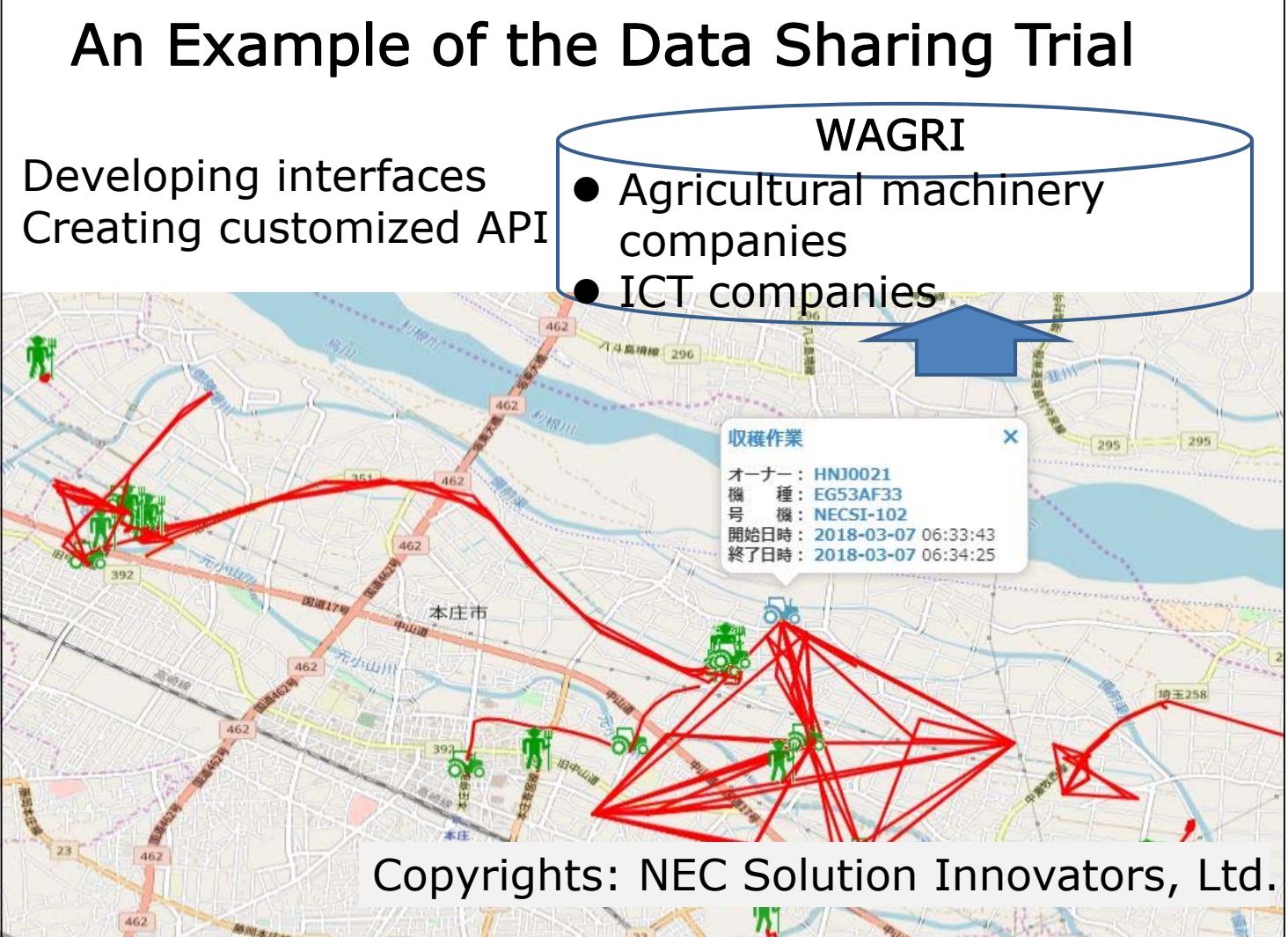
WAGRI enables Rules of Data Sharing

- Data ownership should be protected
- Rules of data sharing should be strictly followed

Farmers   Farmers

IT @ companies   Machinery Companies

API API API   WAGRI

Data access controlling function

Data Storage
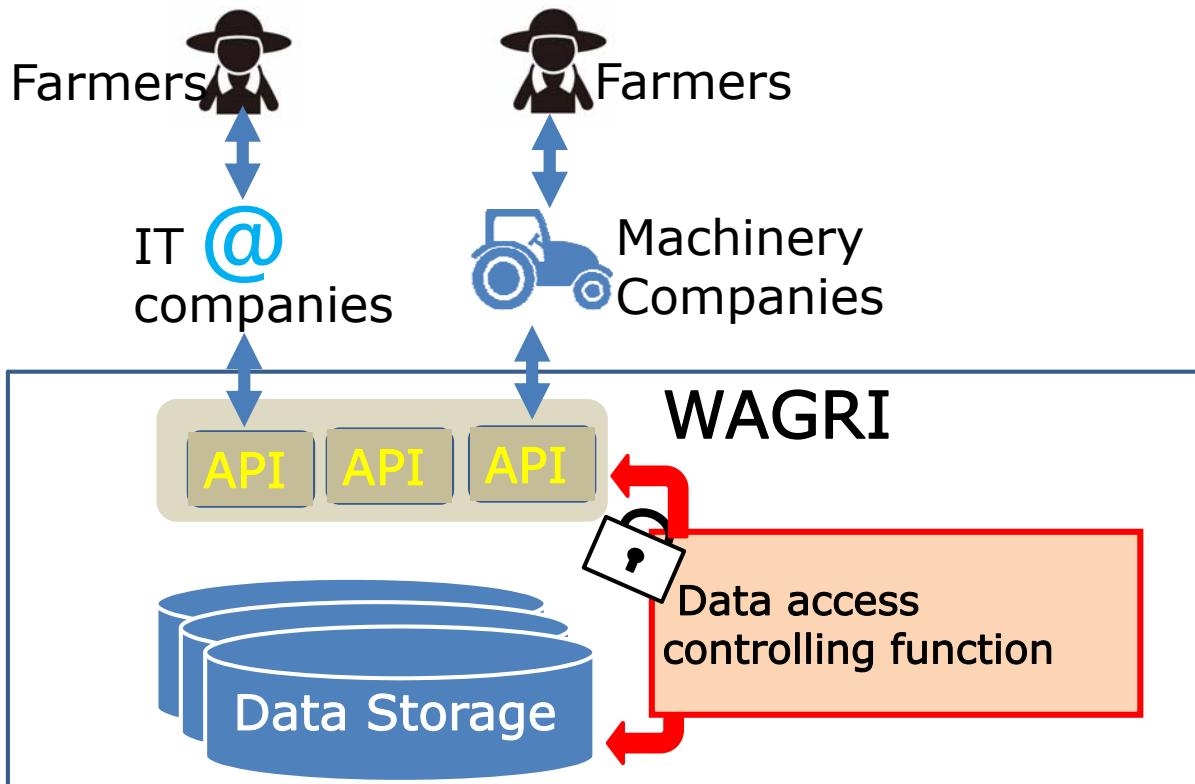
數據共享試驗範例

開發介面
建立客制化API

WAGRI
- 農業機械公司
- ICT公司

收穫作業
オーナー：HNJ0021
機　　種：EG53AF33
号　　機：NECSI-102
開始日時：2018-03-07 06:33:43
終了日時：2018-03-07 06:34:25

版權：NEC Solution Innovators, Ltd.

WAGRI啟用數據共享規則

- 數據所有權應受到保護
- 應嚴格遵守數據共享規則

農民　　　　　　農民

IT 公司　　　機械公司

WAGRI

API　API　API

數據存取控制功能

數據儲存
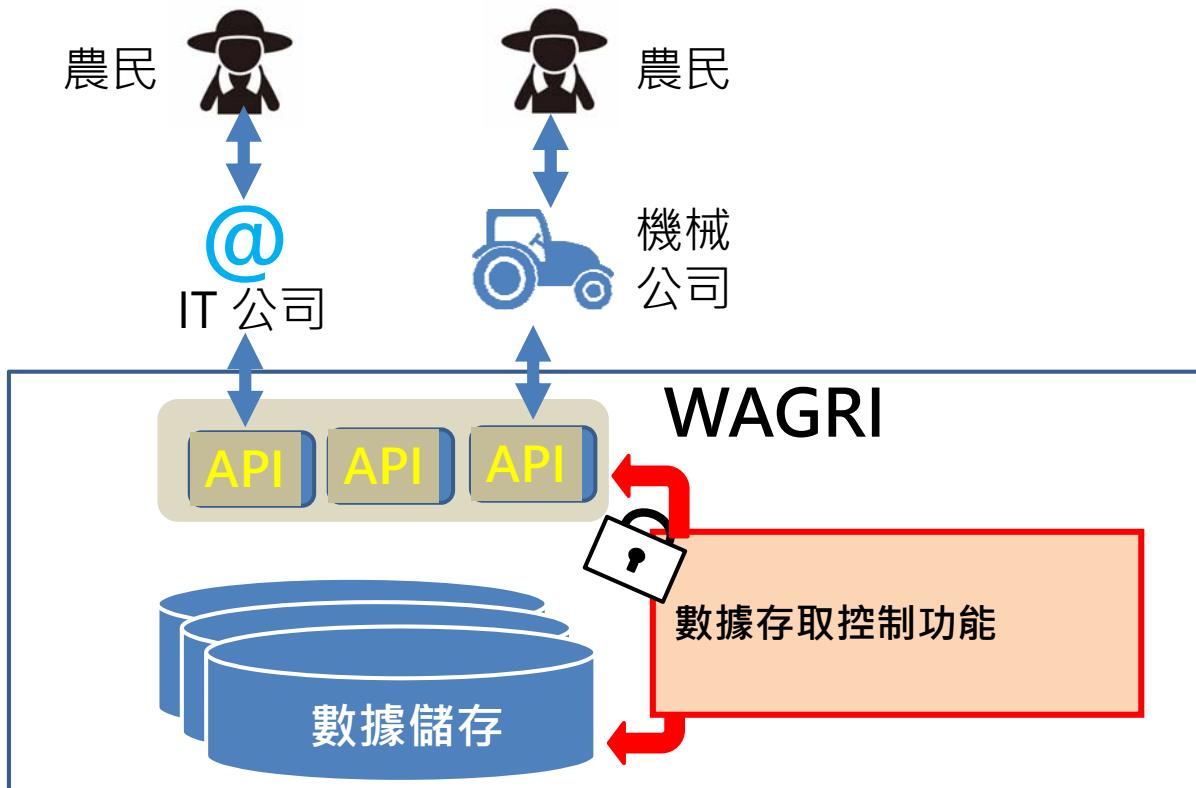
Unmined Data

WAGRI has just started

Possibilities of Local Big Data

1. Akita prefecture is famous for rice cropping
2. Cultivation records of rice crop have been accumulated for **30** years!
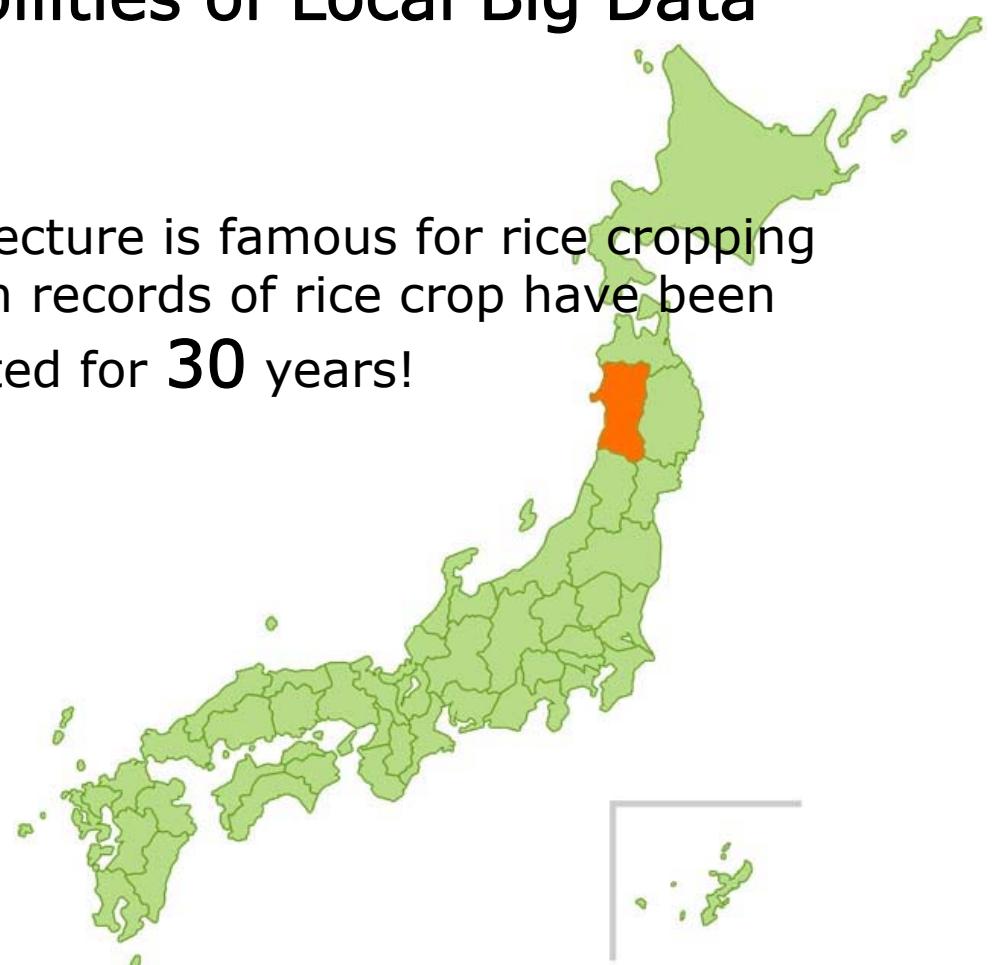
未開發的數據

WAGRI才剛開始

本地大數據的可能性

1. 秋田縣以水稻種植聞名
2. 水稻作物的栽培記錄已累積30年！

Local Dynamics of Agricultural Environment

- Geographical characteristics are diversified
- Climate is dynamically changed

182km

mountaneous

Sea side

basin

111km

Growth of rice crop ?

Unexpected Discovery from Local Dynamics

- Relations between elevation and flowering date
- The relations are against intuitive guess

Flowering date

Basin area

: temperature rises sharply

0m   50m   Elevation
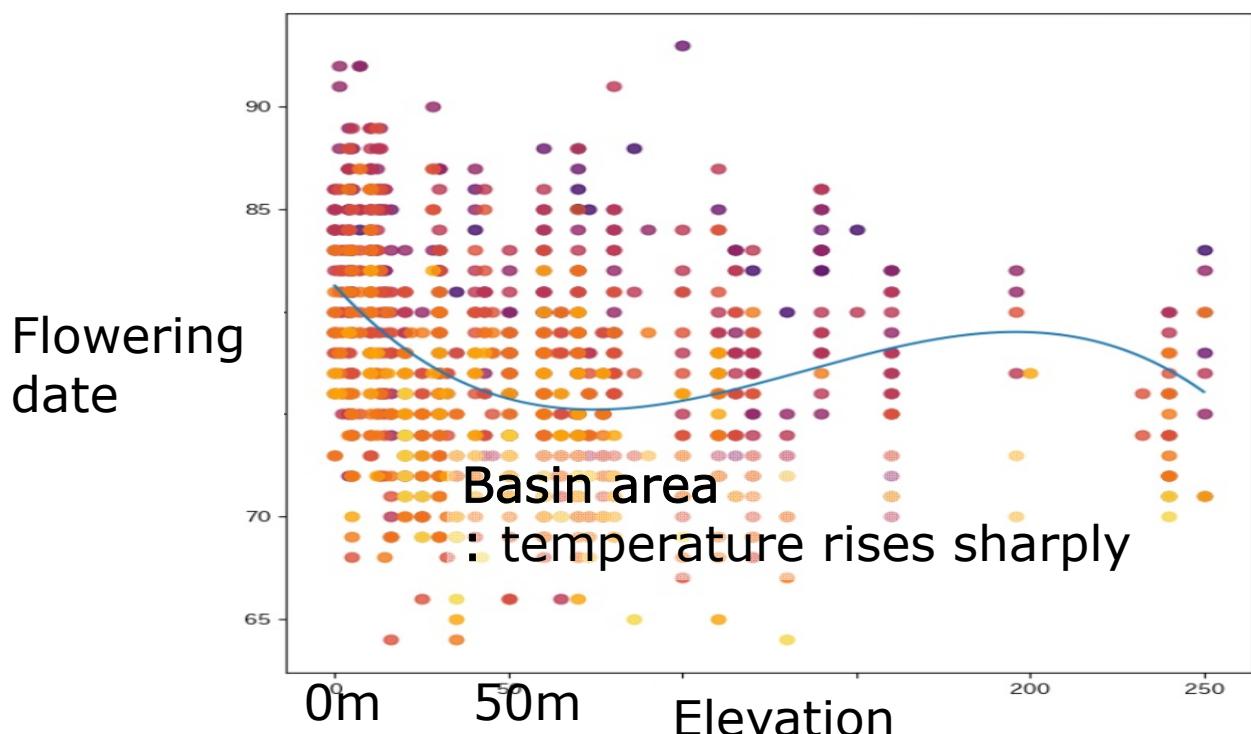
本地農業環境動態

- 地理特徵多樣化
- 氣候是動態變化的

182km

多山

海邊

盆地

111km

稻作生長?
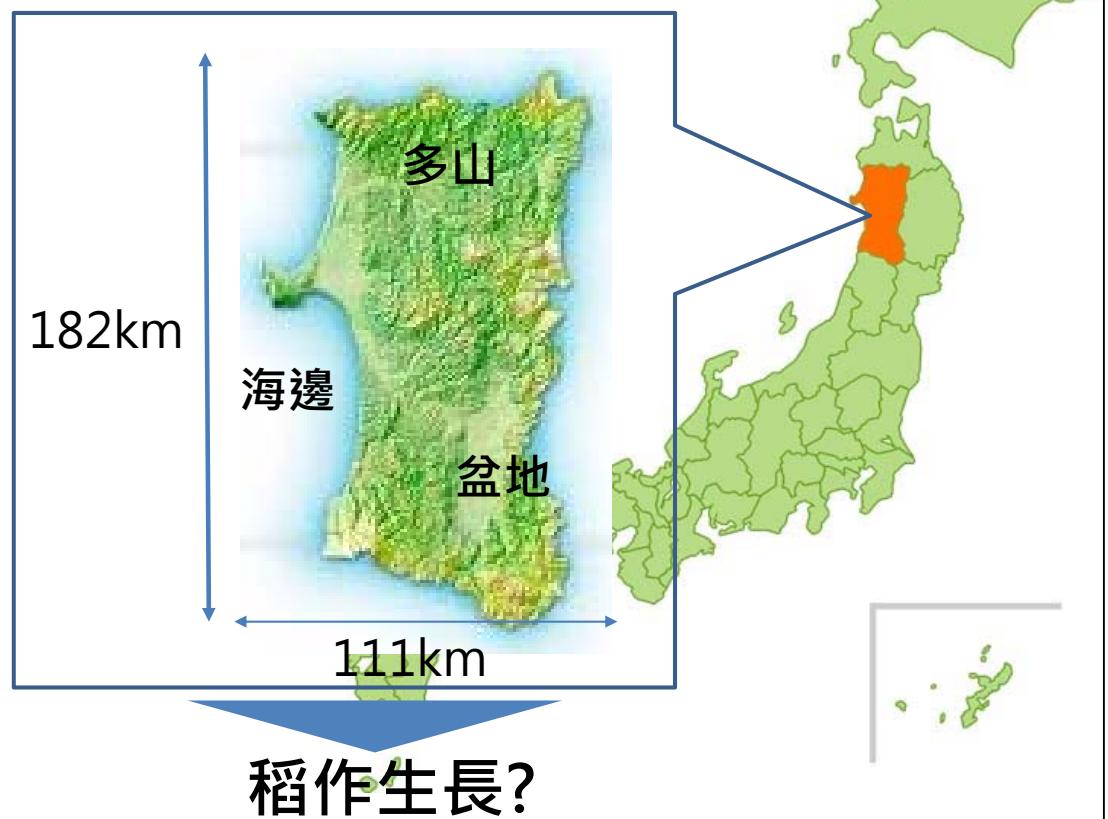
本地動態的意外發現

- 海拔和開花日期之間的關係
- 這種關係與直覺猜測相反

開花日期

盆地地區
: 溫度急劇上升

0m	50m

海拔
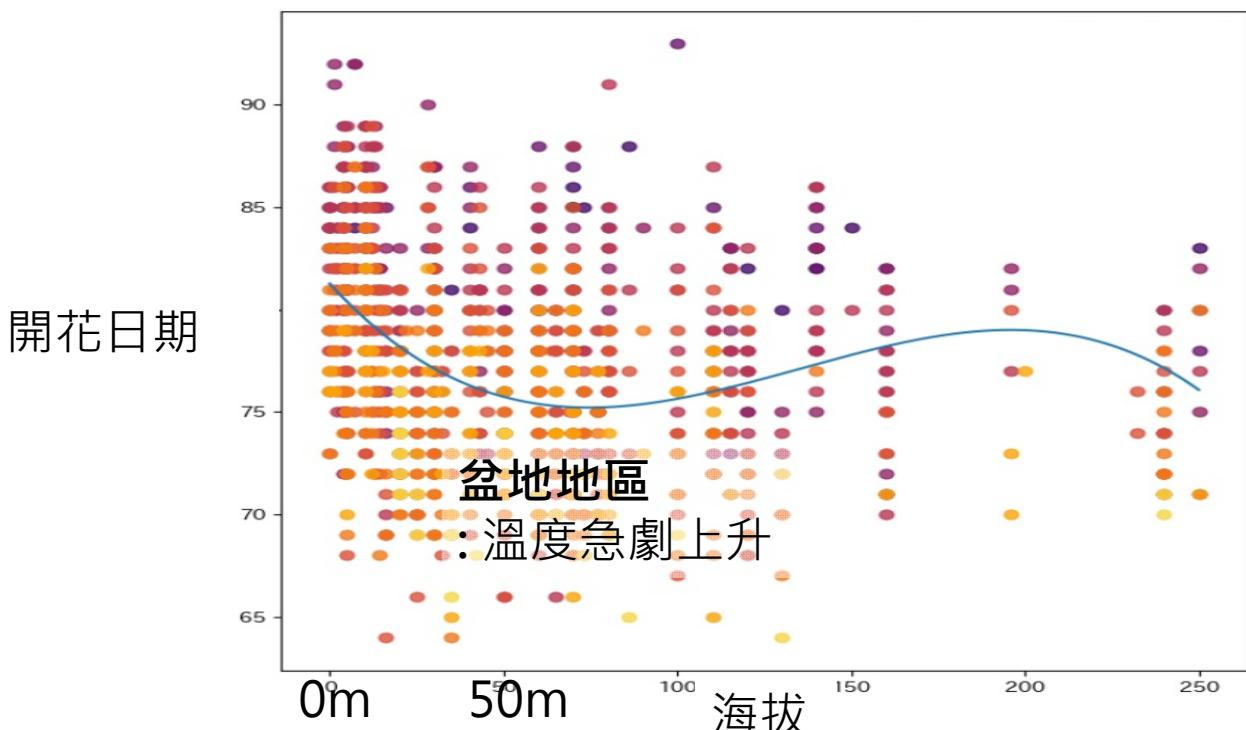
Next Step
'Smart Food Chain'

The Next Stage of WAGRI
Smart Food Chain

agricultural products are vulnerable to conditions

| Exporters | Forwarders | Importers | Retailers |

Refrigerating containers
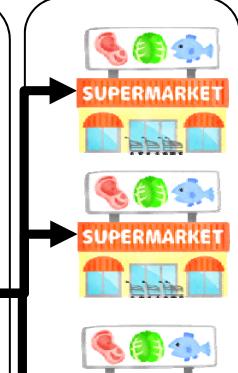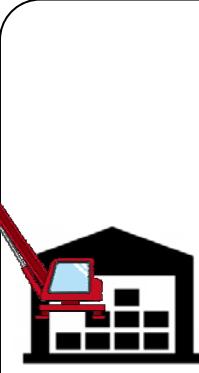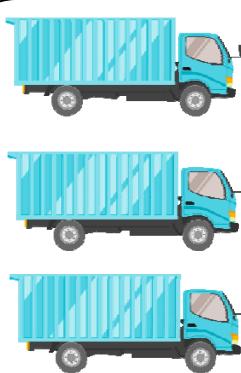
Complex switching of logistics

Healthy ? → Ambiguous

Logging quality data of agricultural products by each switching

下一步
「智慧食品鏈」


WAGRI的下一個階段

智慧食品鏈

農產品易受條件限制

出口商	貨運代理商	進口商	零售商

冷藏貨櫃
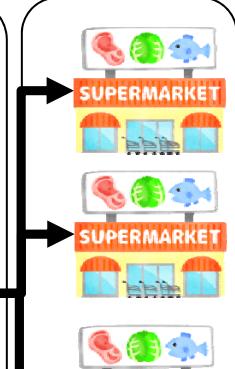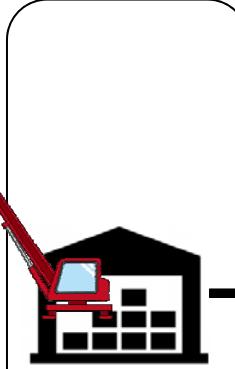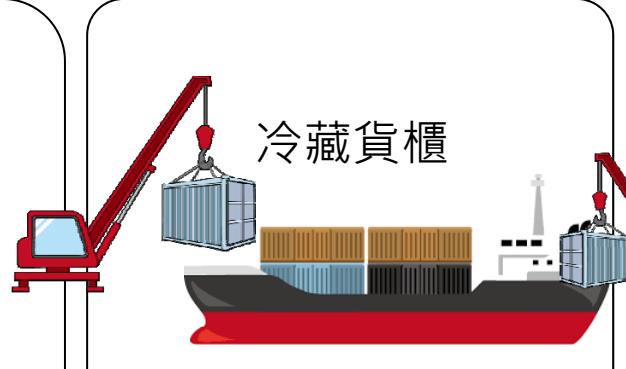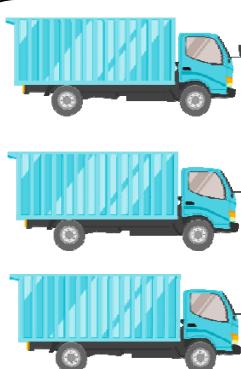
物流的複雜轉換

健康？➡ 有待商榷

透過每次轉換記錄農產品的質量數據

Thank you

Thank you

WAGRI是內閣辦公室跨部門策略創新促進計畫下的「下一代農業」計畫之一，由農業‧食品產業技術綜合研究機構（National Agriculture and Food Research Organization，NARO）管理。

這項工作由日本政府內閣辦公室跨部門策略創新促進計劃（SIP）之「智慧生物工業和農業技術」支持（資助機構：生物系特定產業技術研究推進機構Bio-oriented Technology Research Advancement Institution、NARO）