

Farm Sustainability – Past, Current and Future

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Sustainability Agriculture

- What is Sustainable Agriculture?
 - A broad concept which involves the eco-system of agriculture
 - Growers can use methods to promote soil health, minimize water use, and lower pollution levels on the farm.
 - Consumers and retailers can look for “values-based” foods that are grown using methods promoting farmworker wellbeing, that are environmentally friendly, or that strengthen the local economy.
- Regardless, the existence of **FARMS** or **FARM HOUSEHOLDS** is an essential point.

What are the targets for farm sustainability?

- Concept and Measure of farm sustainability
 - A very broad concept
 - Objective vs. Subjective indexes
- “Profitability” perhaps is the workable and practical index.
 - easy to collect; an objective measurement
- What determine farm profit or farm household incomes?
 - Borrow the wisdom from economic theory (profit maximization; agricultural household model)
 - Farmland, Labor, and Other production inputs (water, fertilizer)
 - Price factors (usually assumed to be exogenous)
 - Government policy (policy implications)

Let us look at Farm Profitability

➤ Economics tell is a lot of story and provides foundation to address this issue.

-- Profit Maximization Model

-- Agricultural Household Model

➤ The Profit Maximization Model

$$\underset{Z,L}{Max} \quad \pi = P \times f(L, Z) \times \varepsilon - \gamma \times L - w \times Z + g(s, L)$$

$$Z^* = Z(P, r, w; s; \varepsilon)$$

$$L^* = L(P, r, w; s; \varepsilon)$$

How Do We Learn from the Profit Maximization Model ?

Agricultural Household Model

- Provide a theoretical framework when time allocation matters.
- In general, farmers can spend time on “farming”, “off-farm work”, and “leisure”.
- This model allows to analyze the off-farm employment, farm production, and government policy at the same time.
- For most of the developing countries, off-farm work plays significant role to determine farm household income.
- This model also allows to discuss the “intra-family transfer or dependency”. Husband vs. Spouse vs. Children

Agricultural Development in Taiwan



What do we learn from this picture?

1. Taiwan is an island

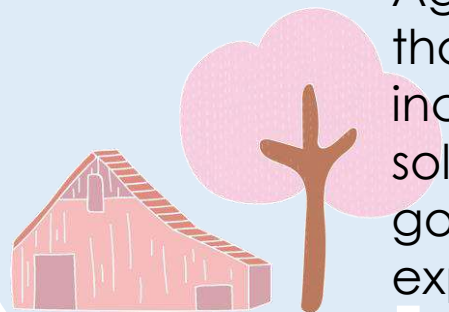
2. Regional Inequality in Economic/Agricultural Development

Participants in Taiwan's agricultural sector



Regular households involved in the raising of crops, cattle, poultry, bee and silkworm rearing, and other production operations.

Farmer and Rancher



Agricultural production units other than farmers, and this category includes corporations, partnerships, sole proprietorships, NGOs, governmental entities, school experimental farms, etc.

Farm and Ranch

- **Agriculture Production and Marketing Groups**

Lack of legal personality, 5,622 groups, and 118,910 members)

- **Agricultural Service Organizations**

(some companies have joined into this sector in the past several years)

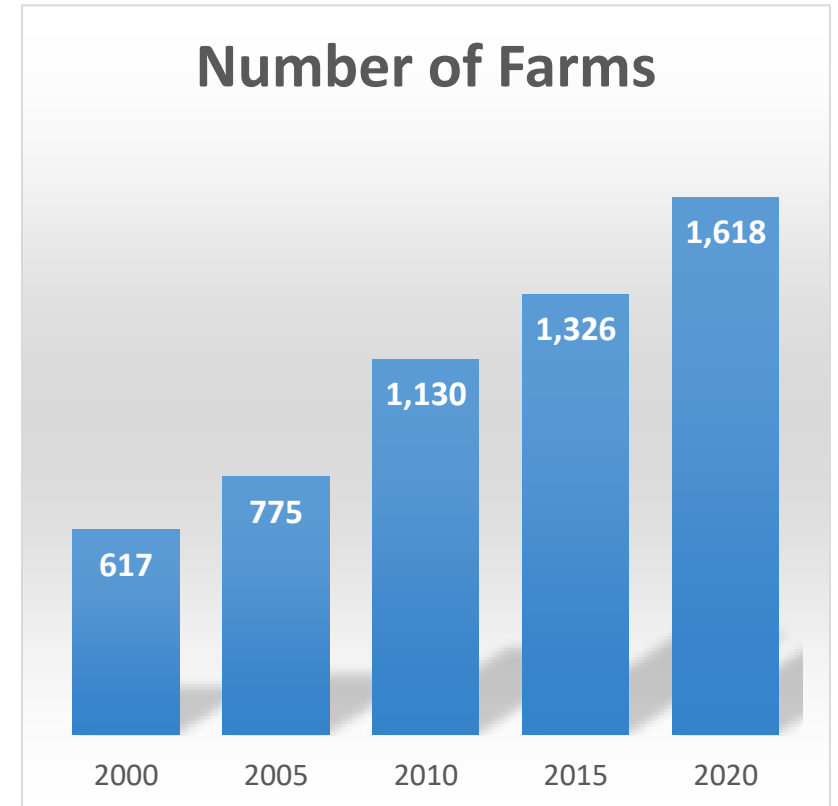
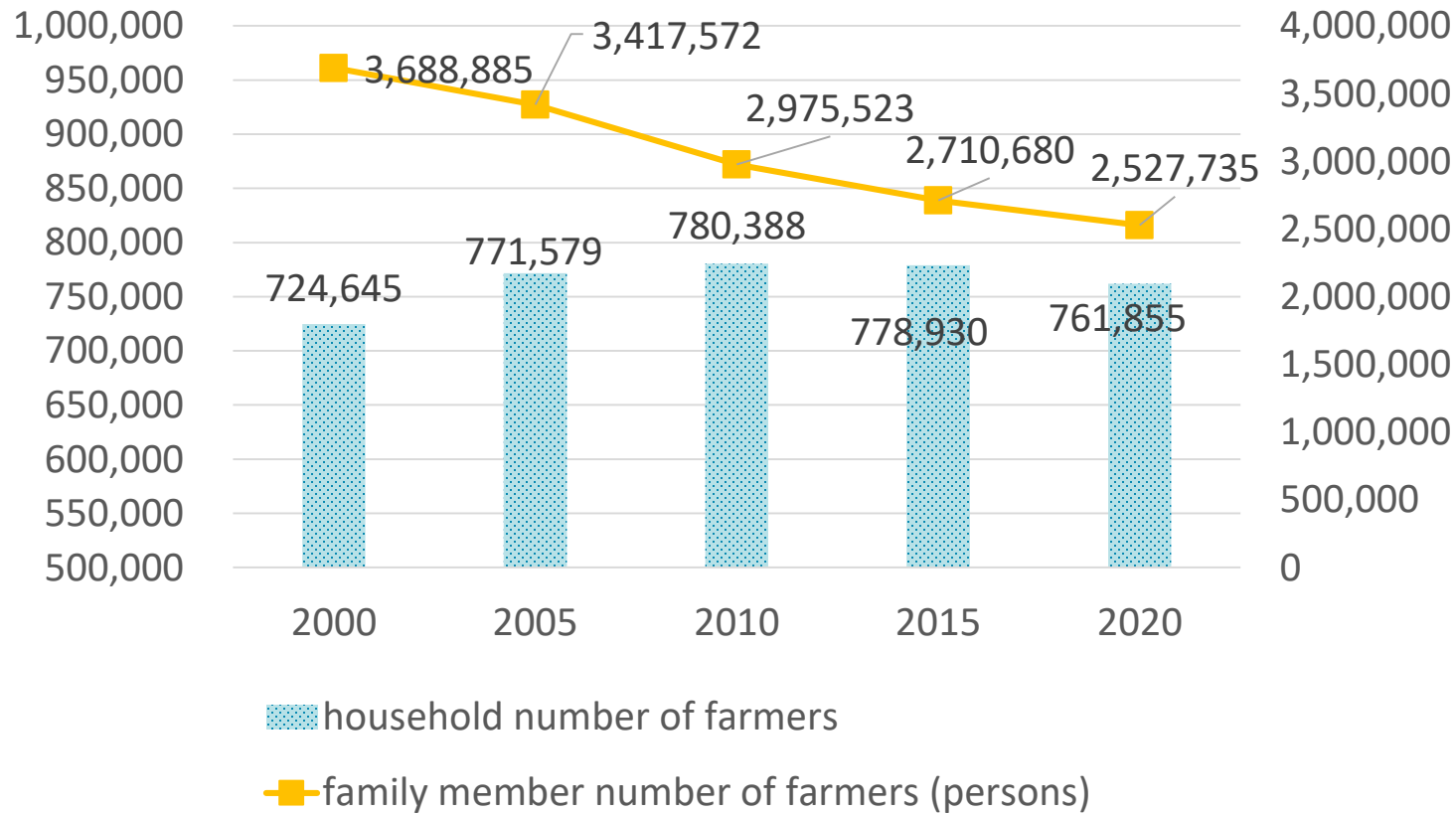
- **Agricultural Cooperative**

- **Farmers' Association**

Offer multifaceted services to farmers, including supply and marketing, promotion, credit, insurance, etc.

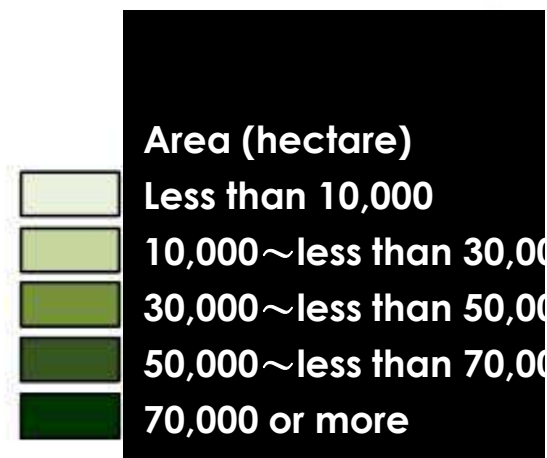
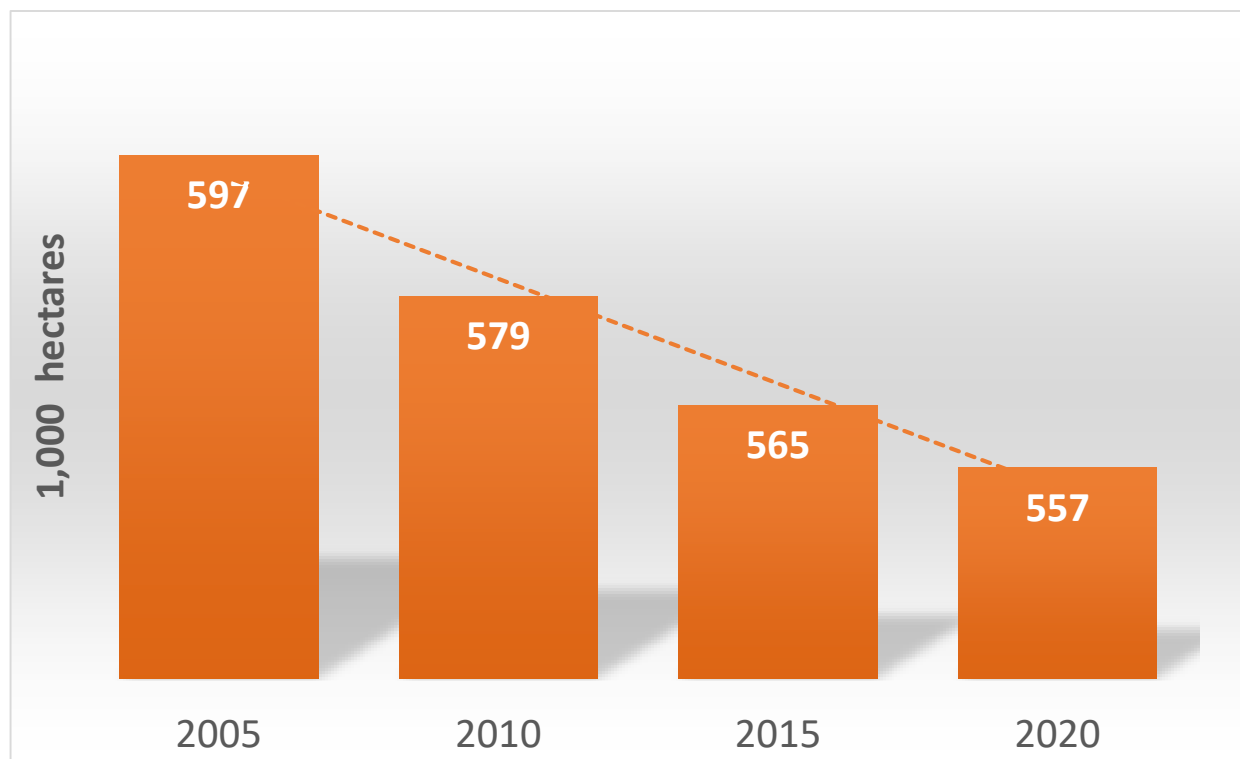
302 associations and 1,745,946 members

Farms in Taiwan's agriculture

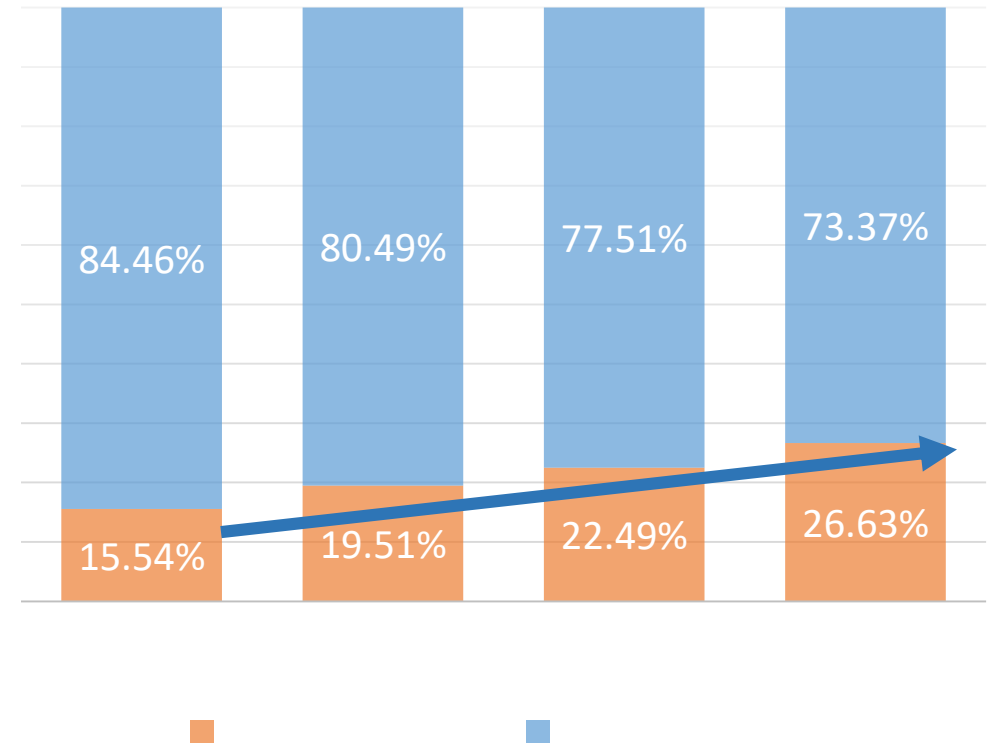
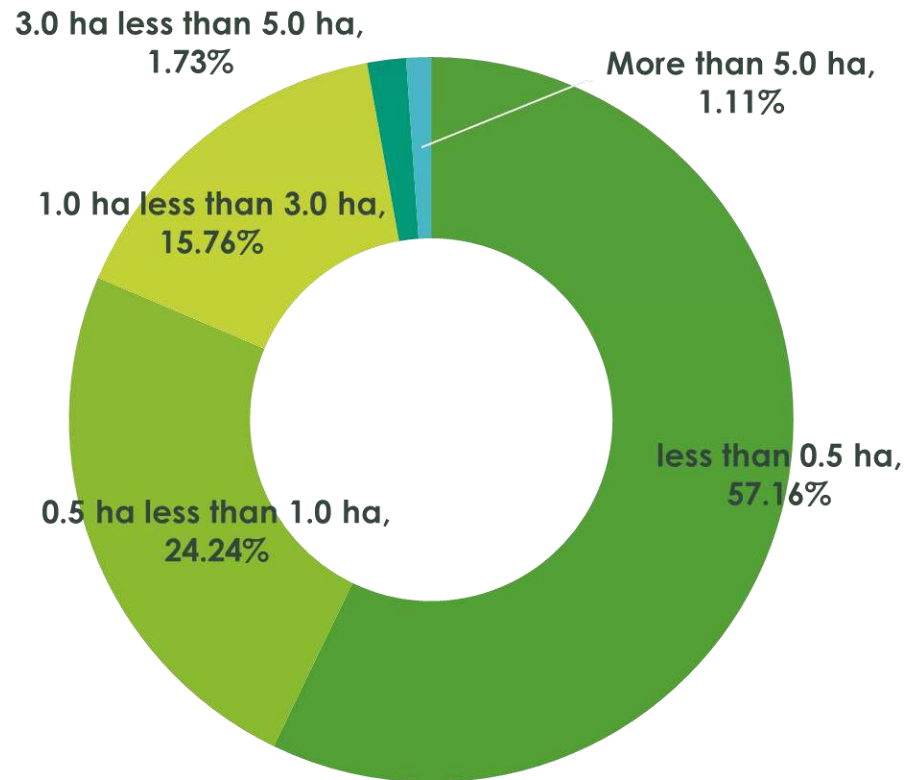


Farmland area and changes

- By the end of 2020, the total area of farmland for agriculture in Taiwan was 557,097 hectares, **with 95.7% belonging to individual farmers.**
- Farmland is mainly concentrated in the southern and central regions. These counties and cities make up 73.5% of the total area.



Scale of arable farmland held by farms



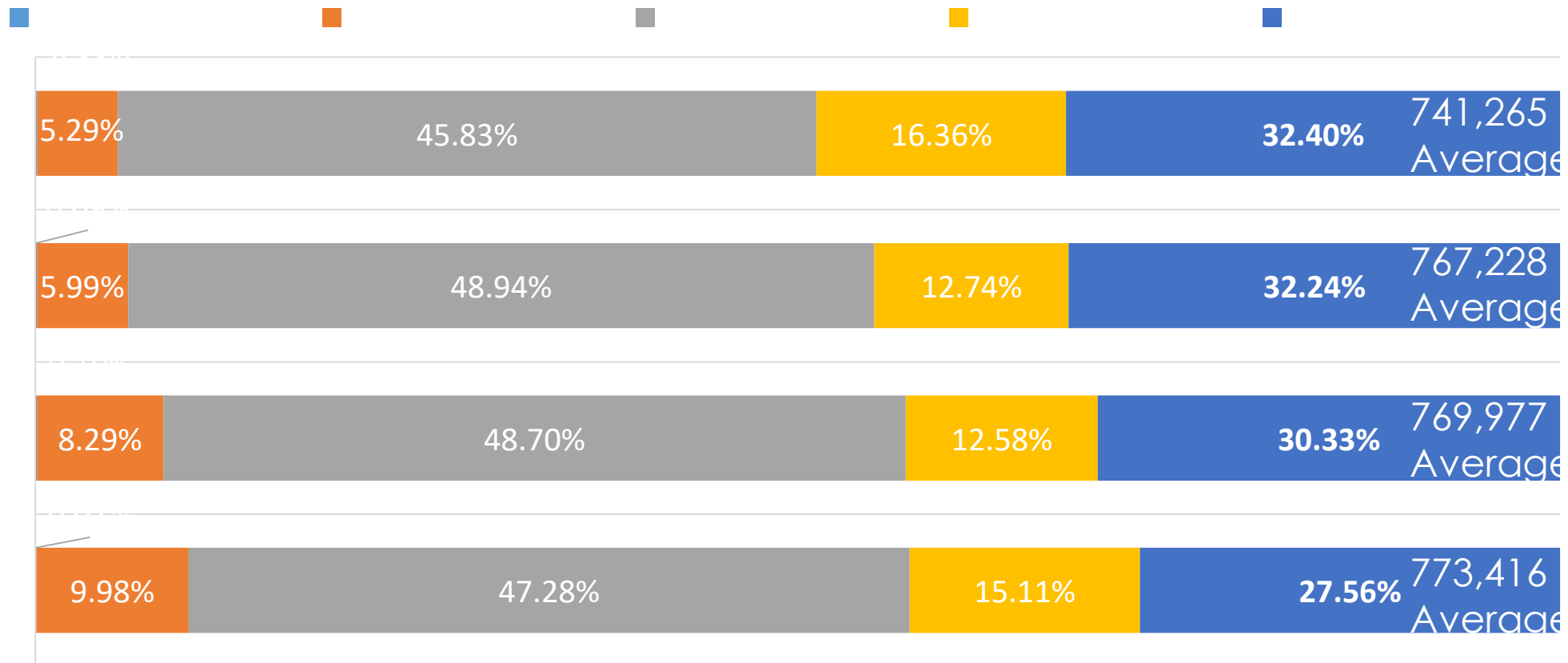
Farm household income

Farming only accounts for 32.57% of their total income.

year	Income per families in Taiwan (NT\$)	Farm		Commercial Farm*	
		Households' Income (NT\$)	Agri. Income (NT\$)	Households' Income (NT\$)	Agri. Income (NT\$)
2017	1,292,578	1,050,176	236,033	1,351,874	497,387
2018	1,310,447	1,099,325	260,730	1,375,478	485,553
2019	1,335,845	1,128,496	271,371	1,407,994	483,311
2020	1,356,343	1,128,493	273,913	1,466,606	490,231
2021	1,378,390	1,173,613	277,558 (23.65%)	1,549,168	504,505 (32.57%)

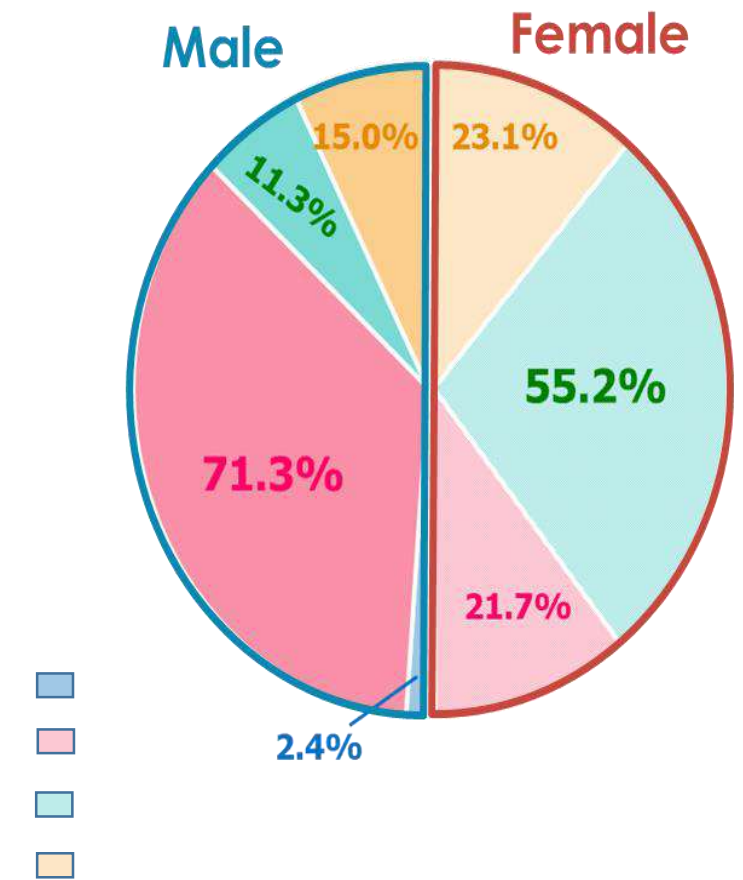
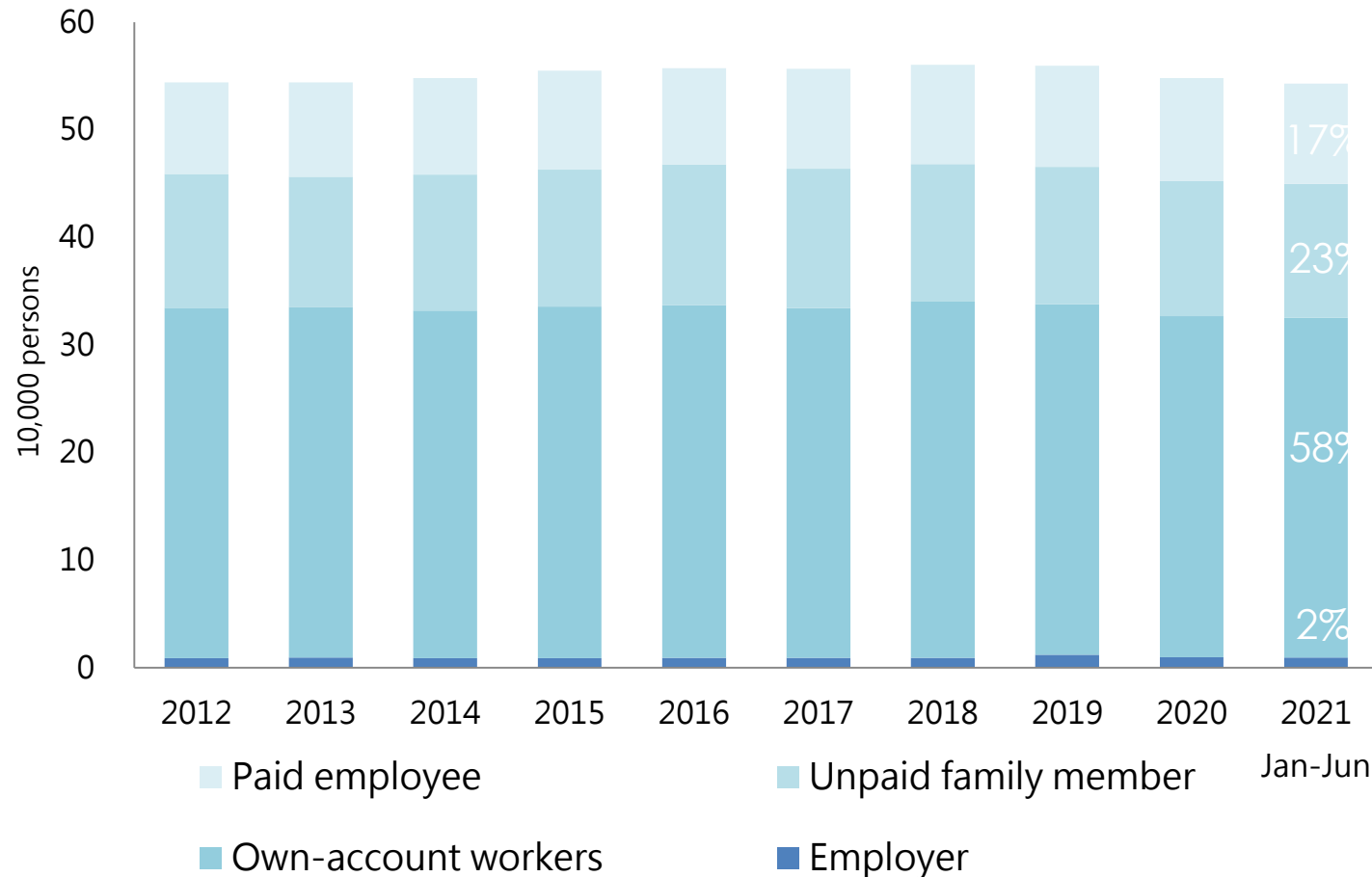
Agricultural operators by age

Managers involved in agriculture, forestry, fishery, and animal husbandry in Taiwan are aging. The percentage of those aged over 65 has risen from 42.7% at the end of 2005 to 48.8% at the end of 2020.



Agriculture demographics by gender

- Most of the agricultural workers in Taiwan are own-account (self-employed) or unpaid family members, with a slight increase in the proportion of paid employees.
- Over 70% of male agricultural workers are self-hired workers, while nearly 80% of female workers are unpaid family members or paid employees. Taiwan agriculture is still primarily operated by males.



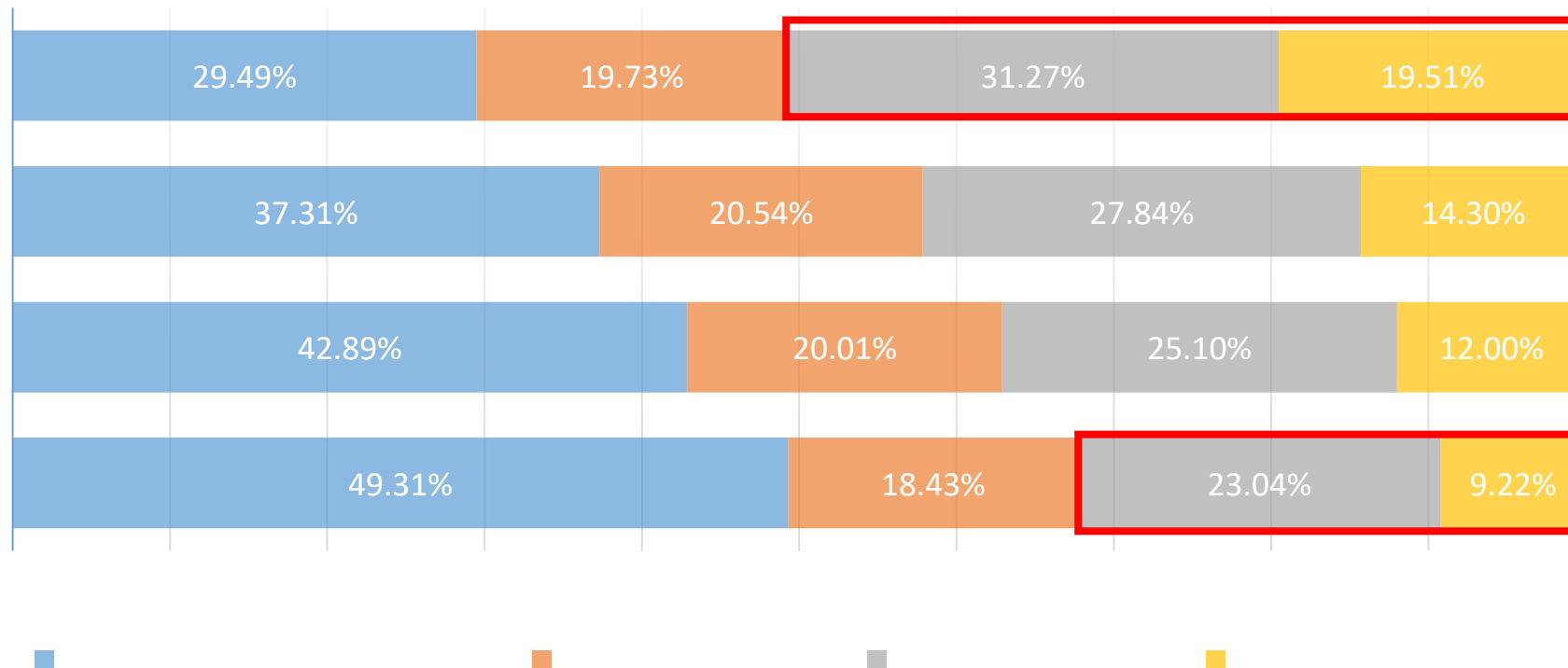
Employee and unpaid workers in agriculture by type of operating organization

Observed by organizational type, farmers employ an average of 2.9 people per household, of which 65.9% are temporary workers; each farm employs an average of 11.8 people, the majority of whom are permanent workers (79.0%).

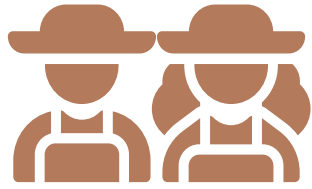
	Total	Permanent Employee	Temporary Employee	Unpaid worker	Average Number of Labor Per Household
Persons					
Total	94,870	28,804	52,751	13,315	3.40
Farmer	76,288	14,120	50,276	11,892	2.90
Farm	18,582	14,684	2,475	1,423	11.80
Percent (%)					
Total	100.00%	30.36%	55.60%	14.03%	
Farmer	100.00%	18.51%	65.90%	15.59%	
Farm	100.00%	79.02%	13.32%	7.66%	

Agricultural Workers' Education

Farmers with a senior middle school degree (high school, vocational school) are 31.3%, while 19.5% had a college degree or higher. It shows that farm workers' educational backgrounds are constantly improving.



Human resource problems in Taiwan



- Aging population
- No family farm successors

- ◆ Policies and approaches for increasing the number of young farmers

- Lack of new entrants
- Lack of local manpower
- Competing with other industries for manpower

- ◆ Policies and approaches for overcoming workforce shortage in the agricultural sector

Working conditions influence people's willingness to work in agriculture

Small scale

- ✓ Small-scale agriculture is unsuitable for automation and mechanization

Uncertain working hours

- ✓ Working hours must correspond to the current state of the climate
- ✓ Seasonal labor shortages

Low income

- ✓ The income is lower than that of other industries

Poor working conditions

- ✓ There is no occupational accident and labor insurance for agricultural workers
- ✓ The environment is hot, humid, or cold

Skills requirement

- ✓ Technical ability was essential for agricultural machinery operators and farm managers



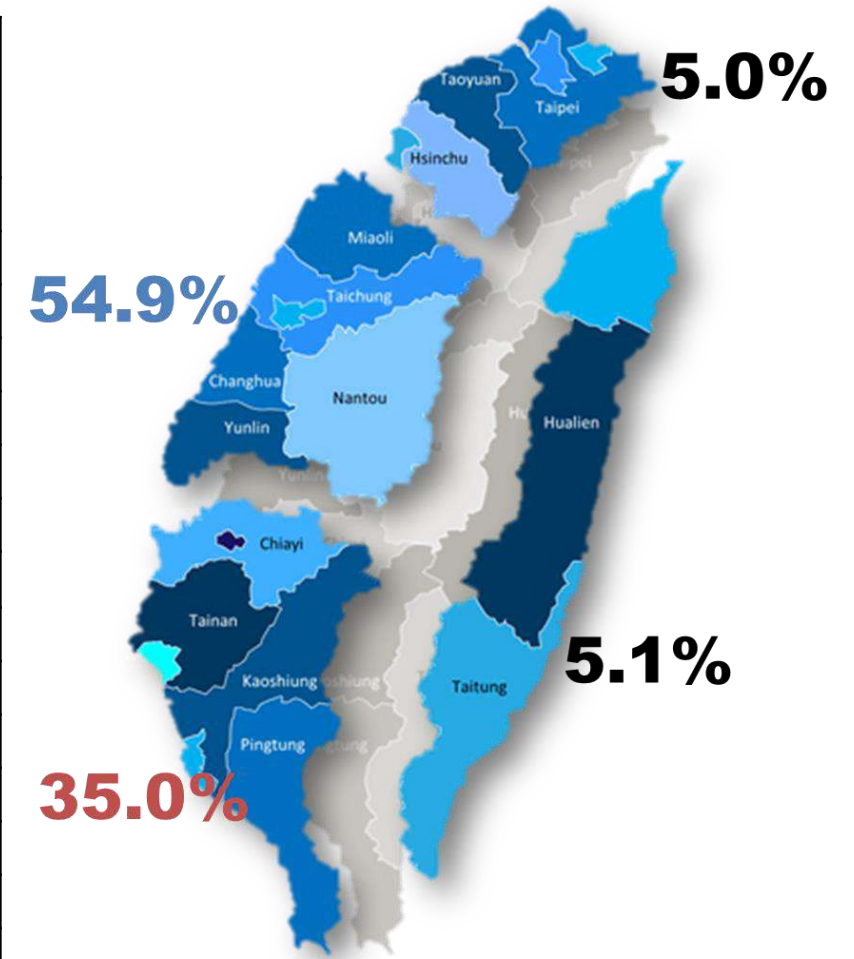
A huge gap with the current situation of agriculture

Most young people want a job with a stable income, social security, and a comfortable working environment.

Temporary labor shortages in the agricultural sector

In 2016, agricultural labor shortages are most prevalent in central and southern Taiwan. These labor shortages have been especially difficult for farmers who cultivate products such as fruits and vegetables.

crop types	total (households)	the proportion of labor shortages (%)	the proportion of temporary labor shortages (%)
Crops	265,093	98.96%	93.03%
Rice	44,570	3.06%	5.55%
Coarse Grains	13,257	1.52%	2.39%
Special Crops	16,196	13.38%	8.36%
Tea	6,924	11.01%	5.42%
Vegetables	61,496	29.51%	27.99%
Fruits	119,132	47.61%	43.76%
Ornamental Plants	4,011	1.66%	2.15%
Seeds	4,187	0.95%	1.60%
Others	2,244	1.27%	1.21%
Mushroom	1,181	0.87%	0.95%
Livestock	11,034	1.04%	6.97%
Dairy	456	0.00%	0.43%
Swine	4,659	0.16%	2.50%
Chicken	3,217	0.85%	2.37%
Others	2,702	0.03%	1.67%



Challenges of Agricultural Development in Developed Countries

For developed countries (such as Taiwan), three significant challenges in agricultural development have been recognized

➤ **Old farm age structure**

-- compared to developing countries, farmers are much older.

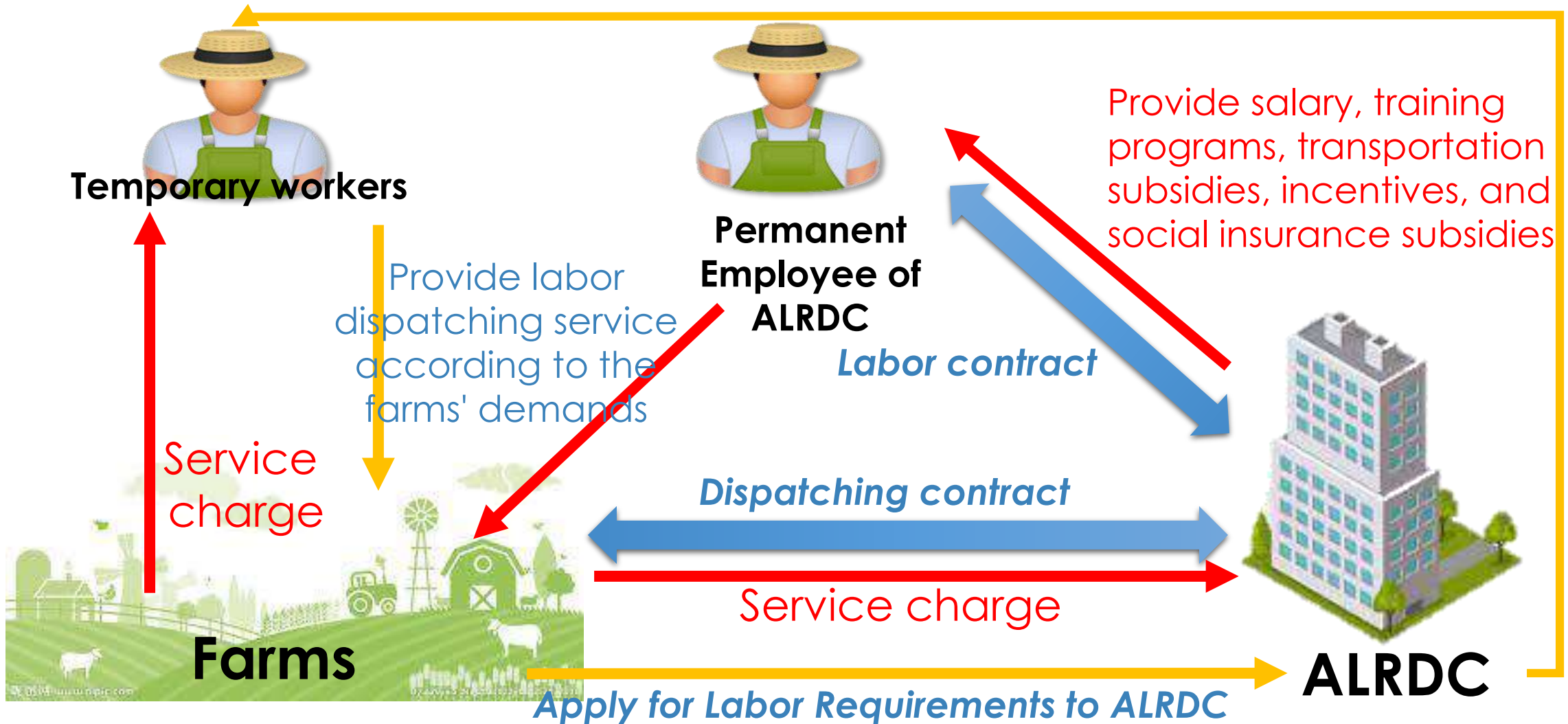
➤ **Shrinking of farm size**

-- the farm size decreased over time.

➤ **Great pressure to import agricultural products**

-- to be consistent with the spirit of the WTO.

Agricultural Labor Matching Platform



Agricultural Human Resources Platform



行政院農業委員會
COUNCIL OF AGRICULTURE, EXECUTIVE YUAN

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Agricultural human resource

農業人才 申請表單 下載表單 最新消息 關於計畫 常見問答

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我要報名
農業耕新團



請來看看今天有什麼工作

工作項目

農場名稱 蔥洋園

工作類型 剪枝、噴藥(肥)、除草、其他

工作型態 全職

作物類型 花卉-其他花卉

推薦工作

套袋
月薪 100,000/月
108/04/15-108/04/17
彰化縣 彰化縣

套袋、除草
月薪 150,000/月
108/04/01-108/06/01
彰化縣 竹塘鄉

剪枝、套袋、其他
月薪 108,000/月
108/03/01-108/05/01
彰化縣 竹塘鄉

剪枝、噴藥(肥)、除草、其他
月薪 26,400元/月薪
108/01/01-108/12/30
彰化縣 彰化縣

通知

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您向「尚自給有機蔬菜農場」請職的工作已登。

推薦工作通知

系統通知

我的通知

Agricultural human resources platform
“A good helper for the shortage of agricultural workers”(APP)

您曾經有下列的困擾嗎？

- 農忙時期缺幫手，該如何有效率找人才？
- 職缺資訊又多又雜，如何聰明找合適職缺？

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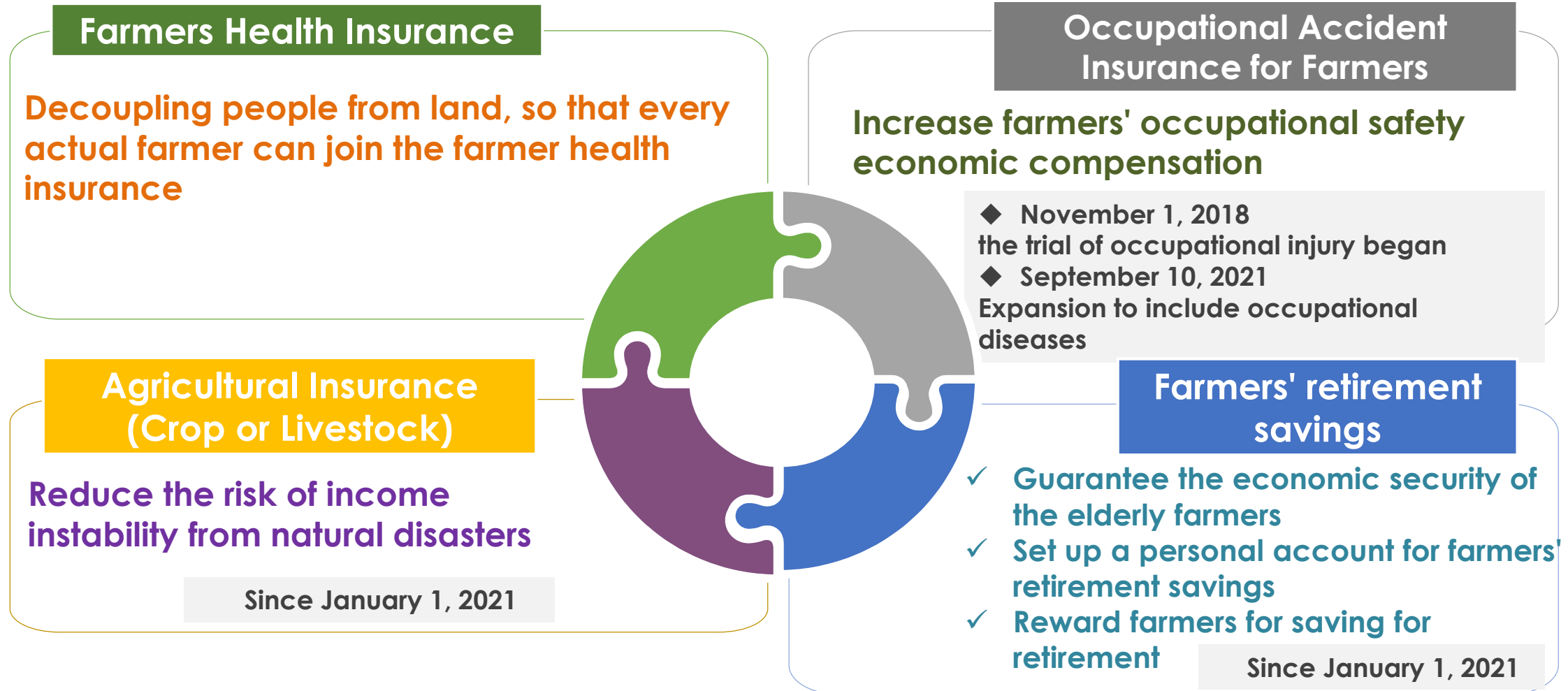
農業人力資源平台

QR Code for App Store and Google Play

主辦單位：行政院農業委員會
執行單位：凌誠科技股份有限公司
洽詢專線：07-9703898#4

Four major farmers' welfare program

(socio-economic safety net for farmers)



Farmer Welfare Program

Old Farmer Pension Program in Taiwan

To secure elderly farmers' economic wellbeing, the National Farmer Health Insurance program (FHI) has been implemented in 1989.

- Farmers aged ≥ 15 year can enroll in the FHI.
- FHI enrollees receive a favorable premium-benefit ratio and a premium subsidy. FHI enrollees pay only 30% of health insurance premium, whereas other sector workers pay 40%.
- In addition to medical services, FHI enrollees receive lump sum payments for maternity, disability, and death as well as a pension upon turning age 65 (the OFP payments).
- In 1995, FHI participants aged ≥ 65 can receive NT\$ 3,000 per month. In 2014, it has increased to NT\$ 7,000 per month.
- The OFP payment is a *as-pay-as-you-go* payment.

Who Are the Farmers You Can See in the Field?



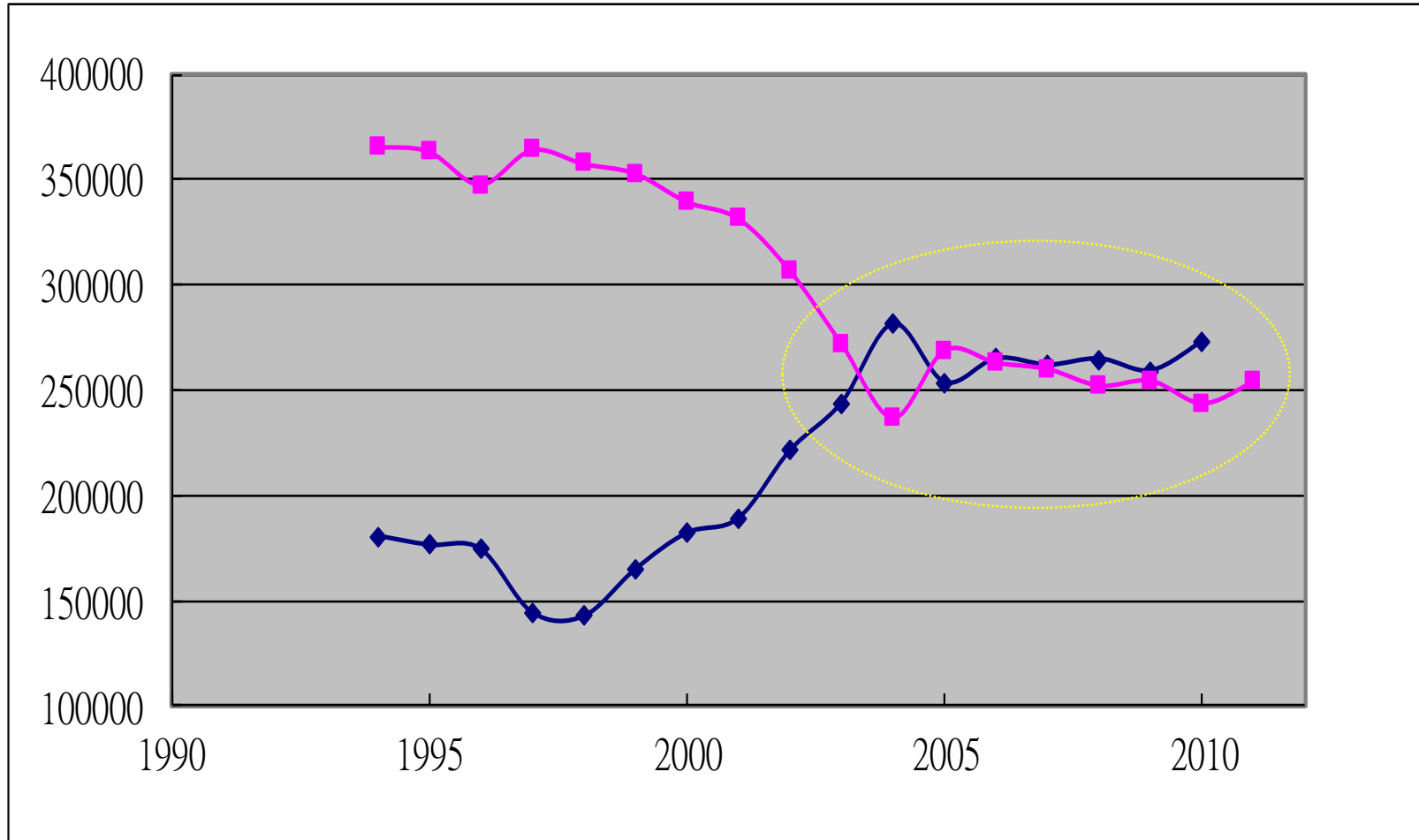
Economic Impacts of the OFP on Farm Sector

- **Account for a significant portion of agricultural budget.**
 - The OFP payments account for 60-65%, on average, of total agricultural financial budget in Taiwan.
- **Lower farm productivity**
 - The OFP payments provide incentives to elderly farmers to stay in agriculture, which lower farm productivity.
- **Delay family farm succession**
 - The OFP payments may crowd out farm labor allocation of the young generation within the family farm.
- **Affect farmland market structure**

Empirical Evidence of the Impacts of OFP

- Chang (AJAE, 2013) used the agricultural census data in Taiwan to show that the **OFP delay family farm succession plans** of the farm households (*recognized as the outstanding paper in Agricultural Extension Association in Taiwan*)
- Chen, Chang and Sun (2016) indicated that the **OFP payments available to elderly farmers increase nonfarm labor supply of the younger generations** within the farm household.
- Fan (ER, 2010) indicated that the **OFP program is responsible for a shrinking family farm structure** over time.

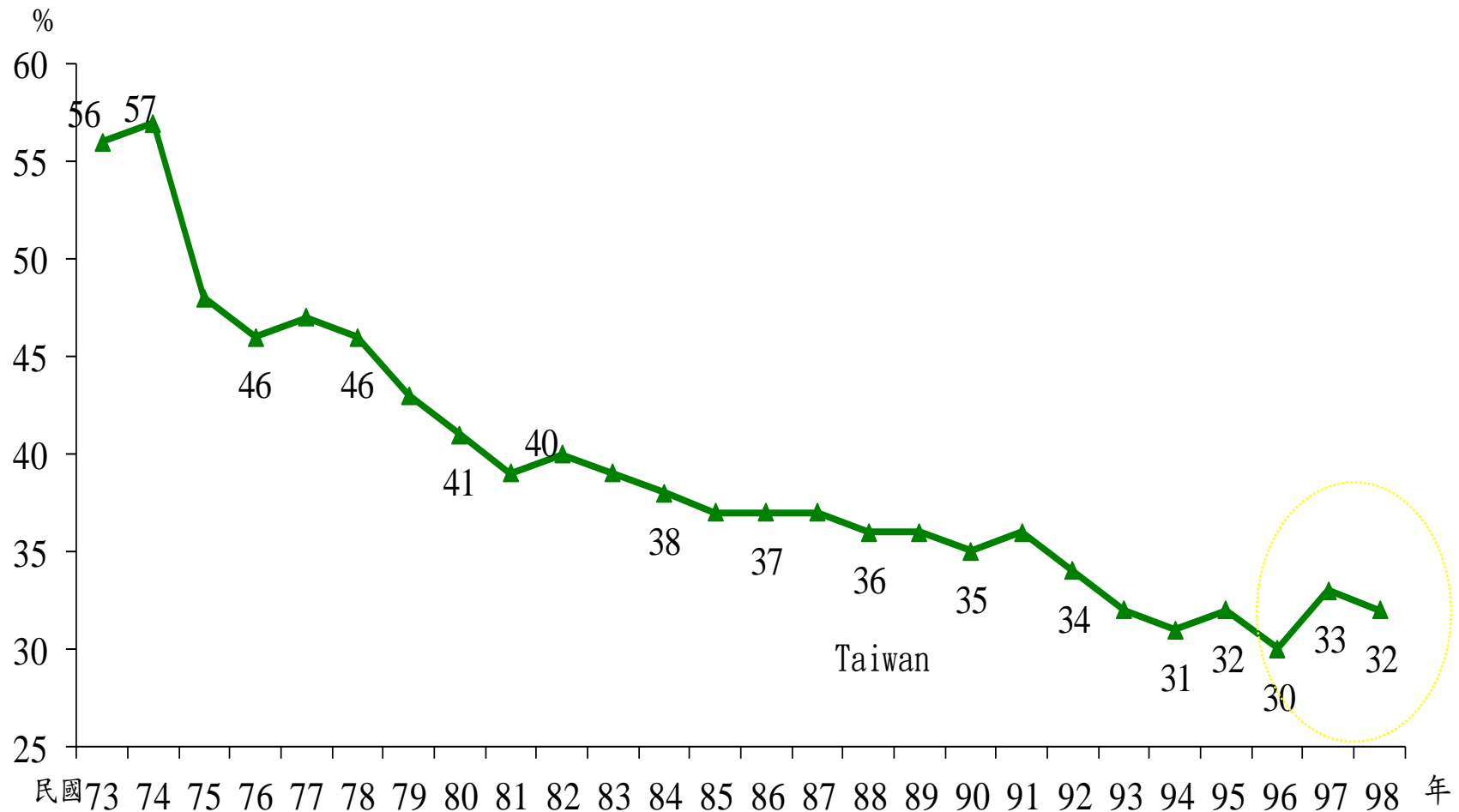
Land for Rice Production and Set-aside



--- Rice Production Land

--- Set-aside Land

Ratio of Food Self-Sufficiency



A Revised Agricultural Development Act in 2000

- Prior to year 2000, only farmers were allowed to purchase farmland and construct farmhouses. In consequence, the sellers and buyers of farmland before year 2000 were farmers, and the purposes of land transaction were largely for farming activities. The policy of agricultural land before Year 2000 was however criticized to have caused the lack of economic competitiveness.
- The Agricultural Development Act was revised in year 2000.

- According to this policy reform, owners of agricultural land who satisfy the following requirements are allowed to construct a house on his land. 1) The age of owners is over 20 or under but married. 2) The registered address of owners shall be in the same city/county as where the land is located. 3) The agricultural land on which farmhouses are constructed needs to be at least 0.25 hectare in size. 4) The agricultural land is in farming uses.
- Not only farmers can purchase farmland after 2000.
- Why the government set the minimum restriction at 0.25 hectare?
 - It is thought that 0.25 hectare is the minimum size for the implementation of machinery and irrigation in farm production.

The Ideal Land Scape



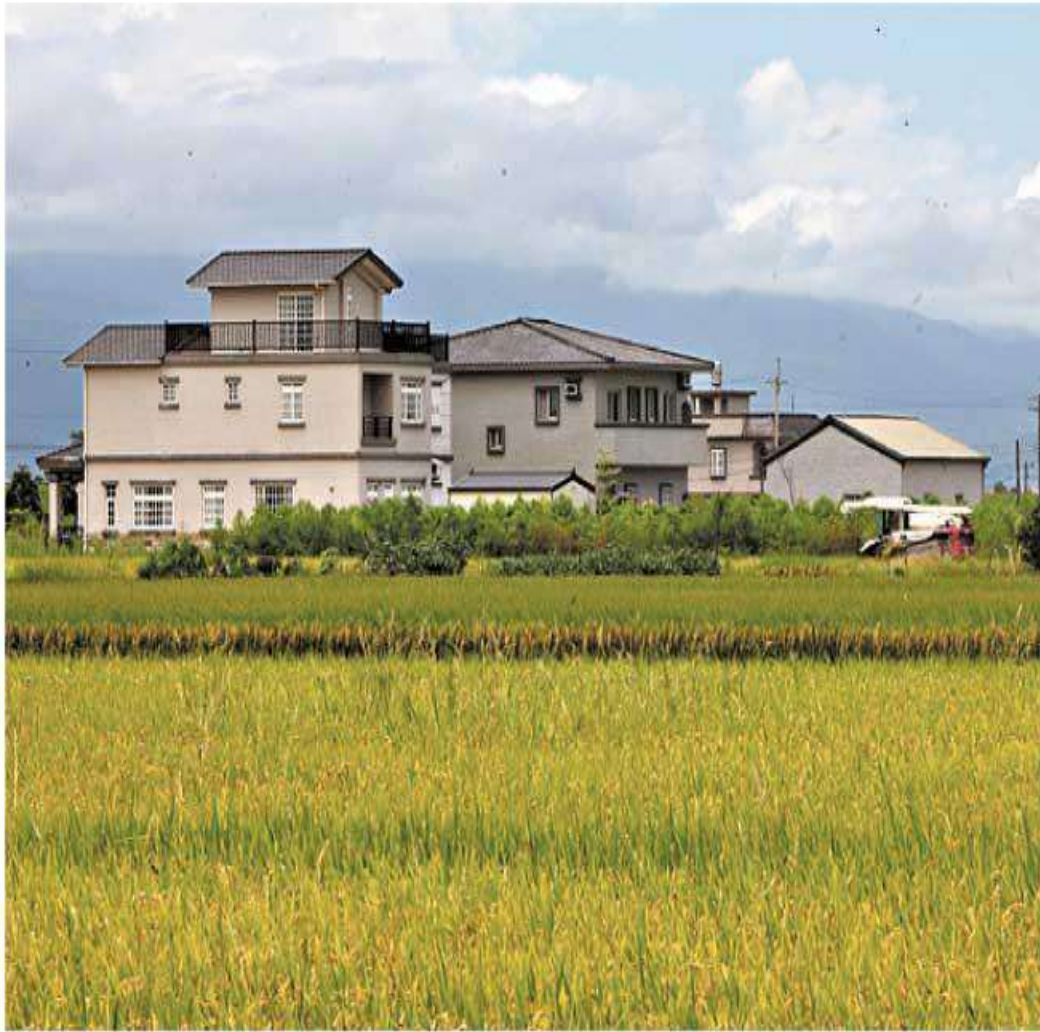
**How Do Farmhouses in Taiwan Look Like
Today After 15 Years of the Agricultural
Development Act Reform?**

A disorganized land scape is observed



Farmhouses in Suburban Area Today

(I-Lan county, 1 hr from Taipei City)



What is Wrong with the 2000 Ag. Dev. Act?

- Chang and Lin (2015) used the foreclosure farmland dataset from 1999 to 2008 in Taiwan to examine the impacts of the 2000 Agriculture Development Act on farmland prices. In particular, they focus on the minimum lot size (MLS) regulation on farmland values.
- They try to address the following issue:
 - *Was the 2000 reform responsible for the increasing trends of farmland prices in recent years in Taiwan?*

Labor Supply Elasticity in a Job Matched Platform – Empirical Evidence from Matched Farmworker-Farm Administrative Data

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Motivation

- Estimating labor supply response is a longstanding research topic.
 - Farm work is challenging due to uncertain weather shocks. Empirical evidence on farmworker's labor supply is sparse compared to non-farm workers.
 - Farm labor shortage is severe in many countries. In East Asia (Japan, Korea and Taiwan), old-aged farm structure is evident.
 - Given acute farm labor shortage, how farmworkers respond to wage changes is of critical importance.
 - Labor supply elasticities are needed to be added and updated to accommodate the nature of changing economy.
- Digital platform economy
- Flexible working schedule for piece-rated work

Literature Review – digital platform

- Advanced digital technology has emerged in our life today (see Uber, Airbnb etc.).
- “Two-sided market” literature states the importance of across-platform externality which may change labor supply of the workers.
- What is the platform externality?
 - Platform owners can charge zero prices on one side, and be compensated by a higher price of the other side (i.e. google).
- Hours of platform workers should be more elastic to wages due to the flexible working schedule. However, on the other hand, workers may be willing to receive lower wages if the across –platform externality is significant.

Literature review – income target hypothesis

- From behavioral economics literature, when workers have reference-dependent preferences and specific income goals, they may use higher wages in a piece rate system to achieve their goal by working fewer hours.
- Studies have found negative supply elasticities in piece-rate systems, especially on taxi drivers (Camerer et al. 1997; Chou 2002; Crawford and Meng 2011; Agarwal et al. 2015).
- U.S farm workers who are paid by piece rates tend to have “income target” behavior (Richards, 2020).

Agriculture and farm labor in Taiwan

- Farm households account for 10% of the registered households in Taiwan.
- Farm labor force relies on family members of farm households.
- The average age of farm operator is 62 years old.
- 80% of the farm household income comes from non-farm work.
- Food security concern generates pressure on agricultural production.
- Labor shortage problem of agricultural work is severe in Taiwan.

Research Objectives

- We estimate labor supply responses of farmworkers in a special context.
 - Job matched platform between farms and farmworkers.
 - In a piece rate scheme of farm labor.
- We highlight the role of **platform externality** on the estimation of labor supply response.
- We test the **income targeting hypothesis** in a job matched online platform for farmworkers.
- We provide comprehensive analysis of labor supply estimates using an administrative matched farm-farmworker dataset.

Online job matched platform in Taiwan

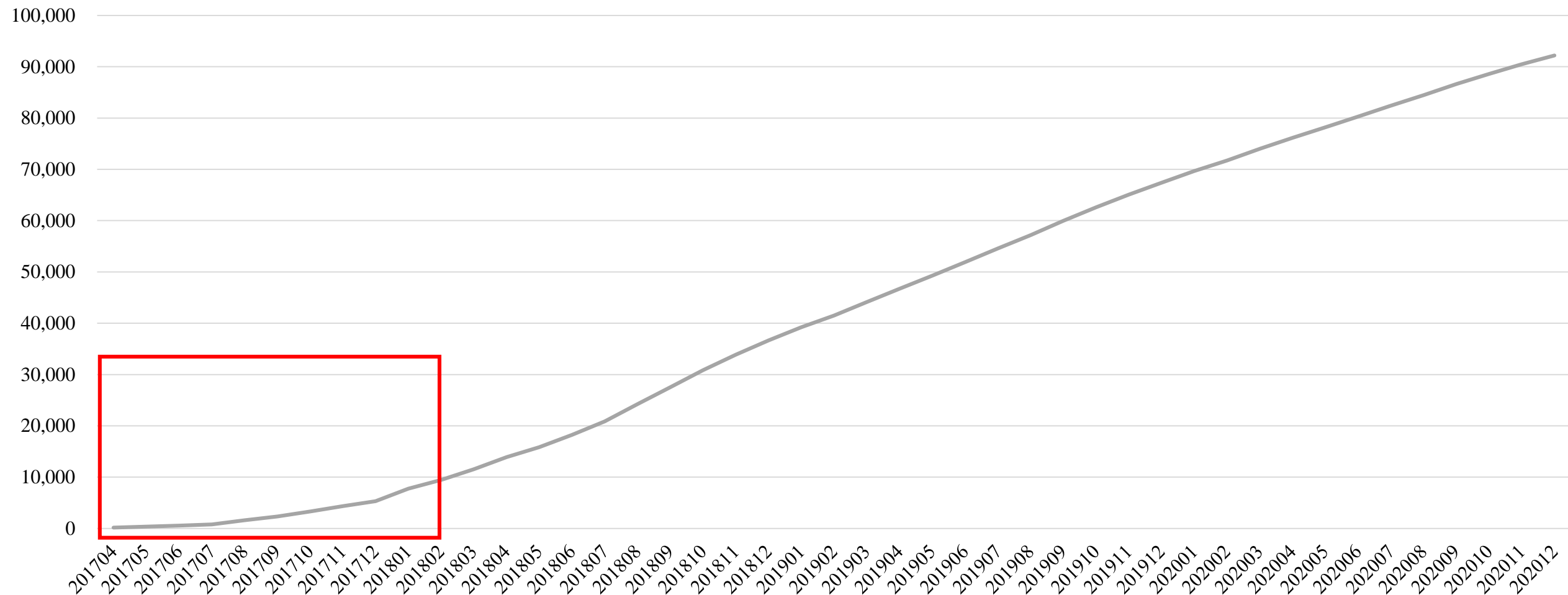
- To mitigate farm labor shortage problem, Taiwanese government launched and sponsored a job-matched digital platform in April of 2017.
- Operation of the platform:



- Wage salary is negotiated between farms and farmworkers.
- Government pays additional subsidies (flat rate per hour) to farmworkers.
- Government provides training programs to farmworkers registered in the platform.

Usage of the platform

Cumulative number of jobs



Data

- Drawn from the administrative record of the platform.
- Include all successful matched pieces of jobs between April 1, 2017 and December 31, 2020.
- Detailed information of farm and farmworker characteristics.
- We can “identify” each farmworker and farm.
- We construct a matched farm-farmworker dataset for each piece of job that is successfully matched in the platform.
- In total, 92,210 pieces of jobs (5,644 farms and 2,059 farmworkers).

Variables (I): Key variables

Variable	Definition	Mean	S.D
Key variables			
Hour	Actual working hours per job (hrs).	58.16	76.73
Matched rate	Matched rate of each job (0-1).	0.73	0.32
Wage	Hourly wage (NT\$/hour).	228	18
Externality	Diversity of farms on the platform (0-1).	0.80	0.22

Variables (II): Job and farm characteristics

Variable	Definition	Mean	S.D
Job characteristics			
Meal	If meal provided (=1).	0.131	0.337
Harvest	If harvest work (=1).	0.558	0.497
Weed	If weed work (=1).	0.419	0.493
Prevention	If prevent work (=1).	0.241	0.428
Prune	If prune work (=1).	0.209	0.407
Thin	If thin work (=1).	0.185	0.389
Farm-specific characteristics			
Fruit	If the farm mainly plants fruit (=1).	0.434	0.496
Vegetable	If the farm mainly plants vegetable (=1).	0.253	0.435
Rice	If the farm mainly plants rice (=1).	0.078	0.269
Flower	If the farm mainly plants flower (=1).	0.023	0.148
Mushroom	If the farm mainly plants mushroom (=1).	0.041	0.198
Tea	If the farm mainly plants tea (=1).	0.024	0.152
Other crop	If the farm mainly plants othercrop (=1).	0.130	0.336
Livestock	If the farm mainly feeds livestock (=1).	0.018	0.132

Variables (III): Farmworker characteristics

Variable	Definition	Mean	S.D
Farmworker characteristics			
Male	If a male (=1).	0.686	0.464
Elementary	If primary or lower education (=1).	0.060	0.238
Junior	If junior high school education (=1).	0.119	0.323
Senior	If senior high school education (=1).	0.410	0.492
College	If college or higher education (=1).	0.412	0.492
Age24	if aged 24 or younger(=1).	0.031	0.174
Age2534	if aged 25-34 (=1).	0.222	0.416
Age3544	if aged 35-44(=1)	0.297	0.457
Age4554	if aged 45-54(=1)	0.230	0.421
Age5564	if aged 55-64(=1)	0.189	0.392
Age65	if aged 65 or older(=1)	0.030	0.170
Training_long	If trained 30 days or more (=1).	0.009	0.094
Training_short	If trained 1-29 days (=1).	0.033	0.179
Training_no	If no training (=1).	0.958	0.200
Employ_self-farm	If originally worked on self-owned farm (=1).	0.107	0.310
Employ_hired	If originally worked on other's farm (=1).	0.408	0.491
Employ_non-farm	If originally had no work (=1).	0.475	0.499
Employ_no	If originally worked off the farm (=1).	0.009	0.096
Team_professional	If an industry profession team (=1).	0.064	0.245
Team_technical	If a technique team (=1).	0.580	0.494
Team_cultivation	If a cultivation team (=1).	0.315	0.464
Team_machine	If a machine team (=1).	0.041	0.199

Econometric Approach

➤ The Fixed Effect Model

$$\log(H_{ipfct}) = \alpha + \gamma \log(W_{ipfct}) + \beta' X_{ipfct} + u_p + u_f + u_t + v_{ipfct}$$

i : job; p : farmworker; f : farm; c : township; t : time

➤ The IV-FE Model

$$\log(H_{ipfct}) = \alpha + \gamma \log(\hat{W}_{ipfct}) + \beta' X_{ipfct} + u_p + u_f + u_t + v_{ipfct}$$

IV: Farm specific average paid-wage rate per day (NT\$/hour).

Empirical Results

Table 3. Estimation results of the hour equations (in log).

Variable	OLS		FE		IV+FE model			
	Hour equation		Hour equation		Wage equation		Hour equation	
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
IV_wage					0.455***	0.024		
log(wage)	1.479***	0.120	1.063**	0.474			0.895*	0.475
Other variables	Yes		Yes		Yes		Yes	
Time FE	Yes		Yes		Yes		Yes	
Farm FE	No		Yes		Yes		Yes	
Farmworker FE	No		Yes		Yes		Yes	
# of farms					5,644			
# of farmworkers					2,059			
# of jobs					92,210			
Weak IV test					362.91			
Adjusted R ²	0.136		0.601		0.987		0.601	

Econometric models: platform externality

➤ Model : Exogenous Platform Externality

$$\log(H_{ipfct}) = \alpha + \gamma \log(\hat{W}_{ipfct}) + \gamma_1 E_{ipfct} + \beta' X_{ipfct} + u_p + u_f + u_t + v_{ipfct}$$

Externality: The number of farm diversity per township per month

➤ Model: Endogenous Platform Externality

$$\log(H_{ipfct}) = \alpha + \gamma \log(\hat{W}_{ipfct}) + \gamma_1 \hat{E}_{ipfct} + \beta' X_{ipfct} + u_p + u_f + u_t + v_{ipfct}$$

IV: Average externality cumulated to the previous months

Results of the platform externality

Table 6. Estimation results of the hour and matched rate equations with platform externality.

Variable	Hour equation					
	OLS		IV model			
	Coef.	S.E	Externality equation		Outcome equation	
Coef.			S.E	Coef.	S.E	
Panel A. Outcome variable: Hours of worked						
IV_Externality			0.837***	0.029		
Externality	0.268***	0.036			0.570***	0.096
Elasticity					0.453	
log(wagehat)	0.762*	0.453	-0.268***	0.076	0.613**	0.253
Weak IV test			830.27			
Adjusted R ²	0.602		0.825		0.017	
Panel B. Outcome variable: Matched rate						
IV_Externality			0.837***	0.029		
Externality	0.141***	0.013			0.257***	0.032
Elasticity					0.204	
log(wage)	0.819***	0.192	-0.268***	0.076	0.761***	0.190
Weak IV test			830.27			
Adjusted R ²	0.588		0.825		0.009	
Time FE			Yes			
Farm FE			Yes			
Worker FE			Yes			
# of farms			5,644			
# of workers			2,059			
# of jobs			92,210			

Econometric models: Income target hypothesis

- We estimate the IV-FE model with unconditional quantile regression model (Firpo et al. 2009).
- A negative labor response for hours in the higher quantiles is a circumstantial evidence for income targeting behavior.



Estimated elasticity of hour to wage



Summary of the main findings

- Farmworker labor supply elasticity is 0.895, which is larger than previous studies in a non-platform setup (0.05-0.27, see Hill et al. 2020).
- The importance of wage and externality on hours of work.
- Bargaining power on hourly wage and hours of work are toward farms rather than farmworkers.
- Externality is positively associated with hours of work.
- Platform externality makes farmworkers less responsive to hourly wage.
- Income targeting hypothesis is evident in piece-paid farmworkers.



Volume 95, Issue 4
July 2013

Old Farmer Pension Program and Farm Succession: Evidence from a Population-Based Survey of Farm Households in Taiwan

Hung-Hao Chang ✉

American Journal of Agricultural Economics, Volume 95, Issue 4, July 2013, Pages 976–991,
<https://doi.org/10.1093/ajae/aat004>

Published: 06 March 2013

Initiate?

Find False Farmers Using Big Data

- The total number of farm workers are 0.54 million, while the number of FHI enrollee are 1.4 million.
- How to find false farmers?
- Cooperation among different agencies of the Council of Agriculture
 - FHI registration profile.
 - Farmland registration file.
 - Income tax profile.
 - National Health Insurance program registration profile.

Old Farmer Pension Program

To secure elderly farmers' economic wellbeing, the Farmer Health Insurance program (FHI) has been implemented in 1989.

- Farmers aged ≥ 15 year can enroll in the FHI.
- Need to hold at least 0.01 hectares of farmland.
- FHI enrollees receive a favorable premium subsidy. FHI enrollees pay only 30% of health insurance premium, whereas other sector workers pay 40%.
- FHI enrollees also receive lump sum payments for pension upon turning age 65 (the OFP payments is NT\$ 7,000 per month).
- The OFP payment is a *as-pay-as-you-go* payment.

Eligibility Rule of OFP Program

Farmer Health Insurance program (FHI)	Farmer's Age	
	≥ 65	< 65
FHI=1	Yes (region A)	No (region B)
FHI=0	No (region C)	No (region D)

Research Objective

- This study contributes to the farm succession issue by using an example of the Old Farmer Pension program in Taiwan.
- To examine the extent to which a social security pension program for old farmers may affect family farm succession behavior.
- To investigate how the effect may vary among different types of farms.
- Causality issue has been carefully addressed.

Data

- The primary dataset is the Agriculture Census Survey in Taiwan in 2005, conducted by the Directorate-General of Budget, Accounting and Statistics, Executive Yuan, Republic of China, Taiwan.
- One principle farm operator is identified for each farm.
- Data on socio-demographic characteristics of the principle farm operator were collected, as well as on farm activities of the farm operator and other family members.
- No information of FHI enrollment is recorded.

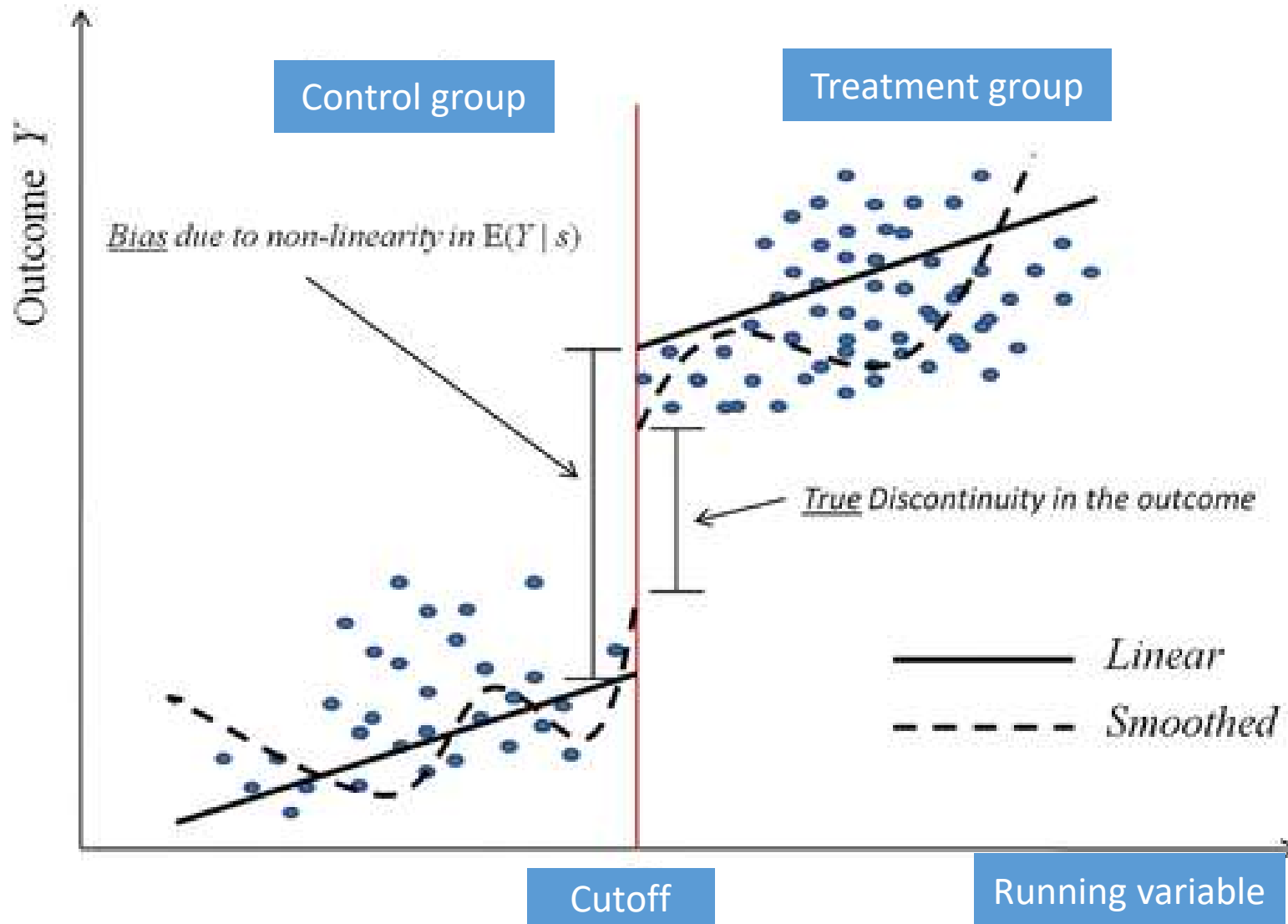
Information of the FHI Status

- To obtain the FHI status of the farm operators, we merged the Agricultural Census Survey with a National Administrative FHI Profiles of the principle farm operators enrolled in the FHI program in 2005.
- For each enrollee of the FHI program, information regarding whether he/she ever received OFP payment is also documented.
- We merge Ag. Census Survey and FHI profile *only* for the principle farm operators.

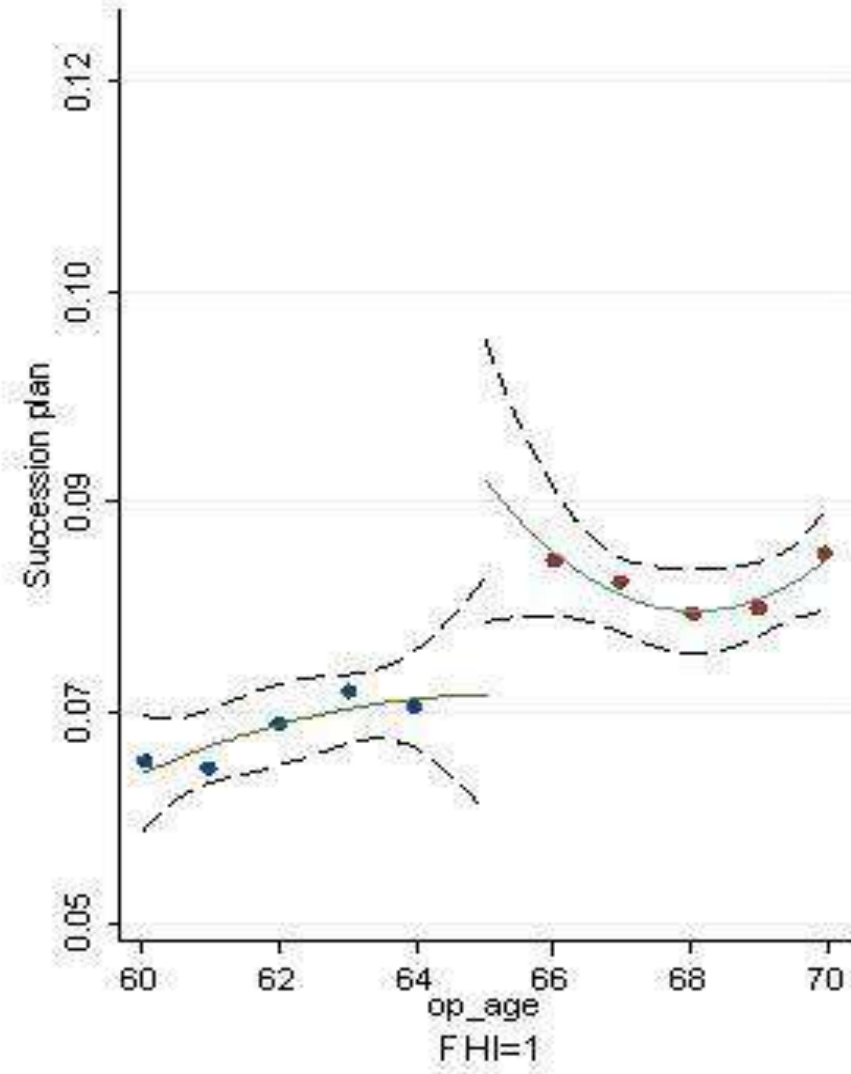
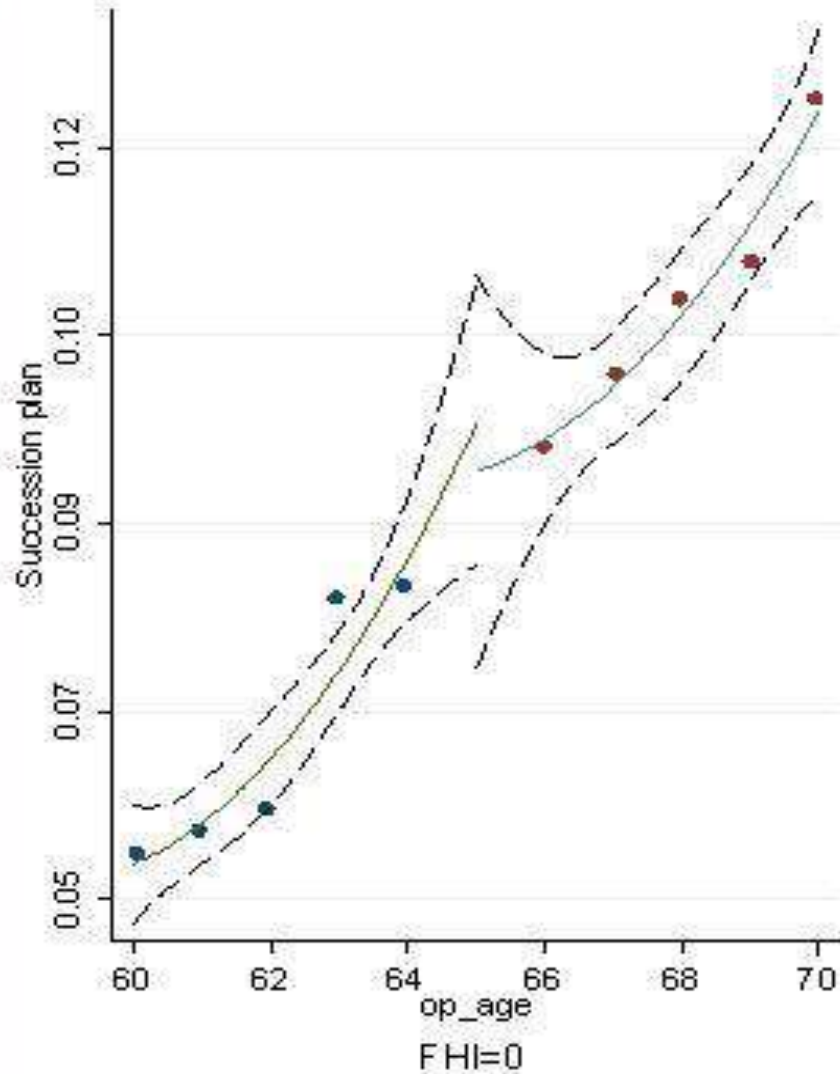
Our Sample

- A final matched sample of 703,287 crop farms. 411,213 (59%) were farms whose operators were enrolled in the FHI program.
- We limit our sample to farms whose farm operator age between 60 and 70.
- We exclude farms whose operators were 65 in 2005 because we do not have the information on the *exact date of birth*.
- The final sample consists of 161,018 crop farm households. Again, each farm has only one principle farm operator.

Regression Discontinuity Design



Snapshot : Is there any *Jump* ?



➤ A RD design with Difference-in-Difference method.

$$Y_i = \alpha + m(a_i) + \tau_1 * OFP_i + \gamma_1 * FHI_i + \gamma_2 * I(Age_i > 65) + X_i' \beta + \varepsilon_i$$

	Age>65	Age<65	Different in Age
FHI=1	$\alpha + m(a_i) + \tau_1 + \gamma_1 + \gamma_2 + X_i' \beta$	$\alpha + m(a_i) + \gamma_1 + X_i' \beta$	$\tau + \gamma_2$
FHI=0	$\alpha + m(a_i) + \gamma_2 + X_i' \beta$	$\alpha + m(a_i) + X_i' \beta$	γ_2
<i>Difference in FHI</i>	$\tau_1 + \gamma_1$	γ_1	τ_1 <i>(diff-in-diff)</i>

Key Findings

- Farm succession is higher for farm operators age >65.
- The succession rate is also higher for non-FHI operators.
- The net DiD effect is negative. That is, OFP payments reduces the likelihood of farm succession.
- The negative effect is more pronounced among fruit farms.

Conclusions

- Our study points out the evidence that there is a tradeoff between the social security program and farm succession.
- On the one hand, a monthly pension payment was paid to old farmers to sustain their wellbeing. On the other hand, this pension also resulted in an undesired effect on farm succession of the family farms.
- Why this is the case? To maintain the eligibility to receive pension, older farmers may choose to continue working on farms, which subsequently delay the intra-household transfer of farm business to their younger generation.



Using Land Zoning to Regulate Solar Farms – A Case Study of Taiwan

Hung-Hao Chang

Professor, National Taiwan University

Tzu-Chin Lin

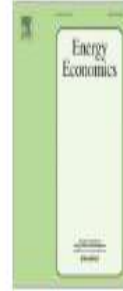
Professor, National Chengchi University





Energy Economics

Volume 99, July 2021, 105317






Journal of Environmental Management

Volume 344, 15 October 2023, 118454



Solar power promotion plans, energy market liberalization, and farmland prices – Empirical evidence from Taiwan

[Brian Lee](#) , [Hung-Hao Chang](#)  , [Szu-Yung Wang](#)

Research article

Solar farm policy and farmland price – A land zoning perspective

[Hung-Hao Chang](#)^a  , [Tzu-Chin Lin](#)^b 

Motivation

- Research attention on renewable energy sources commonly focuses on infrastructure such as wind turbines and transmission lines, and ignores facilities demanding a large and concentrated amount of ground surface, for example, solar panels.
- Trade-off between solar panels and preservation of farmland is discussed. Governments need to find land to accommodate installation. A solar power policy depends on whether governments can find or allocate the appropriate sites for solar panel installation through land use regulations.
- In some areas, it is difficult to develop large-scale facilities for solar energy due to the limited stock of land. Small-scale solar panels have therefore become the necessary alternative mode.

Different Type of Solar Panels



Solar panels on farmland in Taiwan

- The promotion of solar power was initiated in 2004 by government, and farmland is being used to place solar panels. Small-scale open-ground type solar panels are popular and primarily located on farmland.
- Criticism has been raised regarding the competition between farm production and the placement of solar panels on farmland.
“Farmland should be used to feed people, but not for energy” !



How did the reform do with solar panels?

- On July 7, 2020, the government launched a revised land zoning regulation tightening the grant of application for small-scale solar panels installed on farmland smaller than 660 square meters (m²).
- Prior to the revision, both farming and solar energy generation were permitted on farmland under 660 m². However, no solar panels were allowed to be built on farmland under 660 m² after July 7, 2020.
- Exemption: land subsidence areas are designed as priority zones for solar panels. These areas are not affected by the policy.

Research Objectives

- We examine the price effect on farmland due to the revised zoning regulation on the placement of small-scale open-ground type solar panels in Taiwan.
- We use a quasi-experiment policy scheme to identify the causal effect of the policy on farmland prices since the use of solar panels on farmland was tightened.
- We investigate the heterogeneous price effect of the policy by regions and by the productivity of farmland.
- We study the dynamic effect of zoning revisions. In particular, we examine whether the price effect varies over time following the revised policy on zoning.

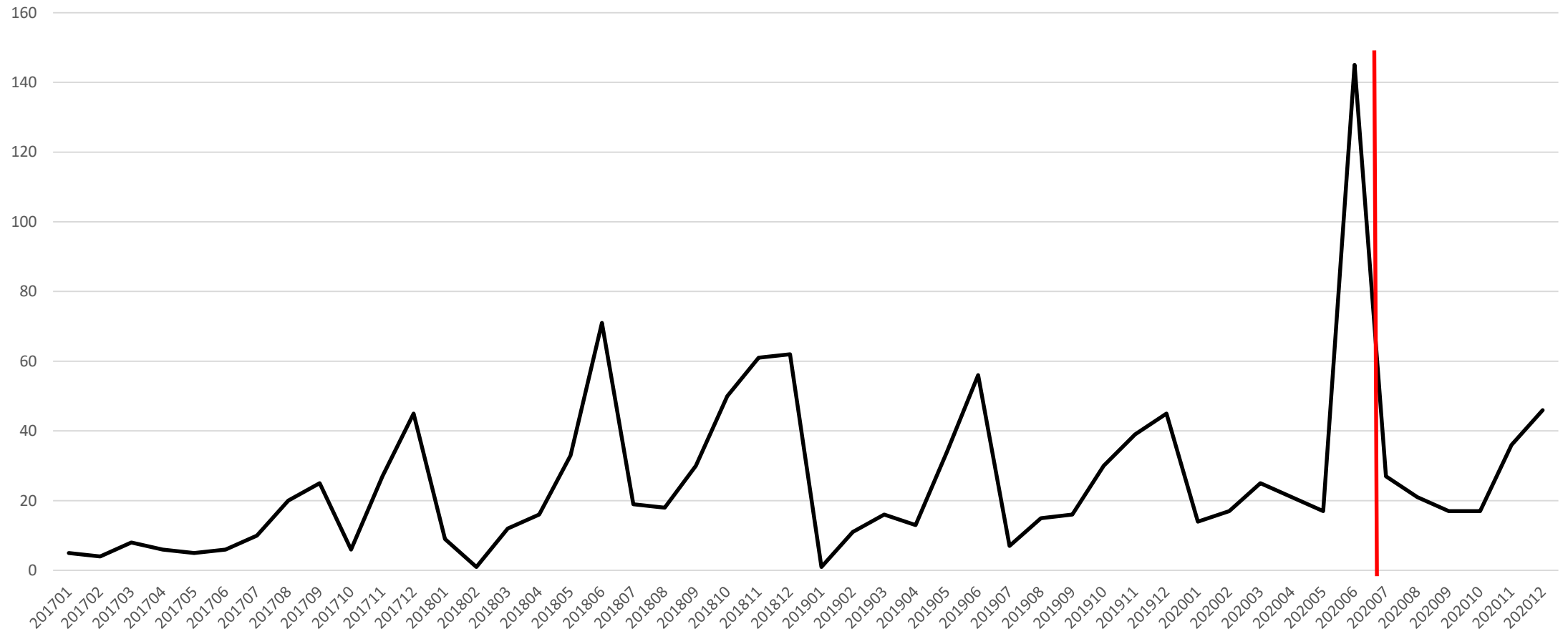
Contribution of this paper

- Very few studies focused on the zoning regulations of small-scale solar panel systems on farmland (Best and Truck 2020). Our study shows that the effects of changes in zoning regulation on wide-spreading small-scale solar energy generation on farmland and its accompanying impacts on farmland prices shall not be ignored.
- Previous studies examined the existence of the solar panels on the prices of the surrounding properties to test not-in-my-back-yard (NIMBY) theory. In contrast, we focus on a case that farmland are not close to a solar panel, but instead those initially with an opportunity to construct solar panels but later denied by a policy change.
- Studies on the price impacts on farmland as a potential site of solar panel associated with a change of zoning codes are rare. In our study, the legitimate use of solar panels was removed from farmland under 660 m² when changes in the zoning codes took effect.

Data

- **Administrative data of farmland transactions in the open market**
 - Managed by the Minister of Interior, and it is a population dataset.
 - Includes the sales prices of the property, physical characteristics, geographical location, time of the transaction.
 - We limit our sample to farmland and exclude transactions that were not sold in the open land market. Also exclude those inherited within family members, with government for public use, within same company. We also exclude transactions in land subsidence areas.
 - Final sample consists of 30,290 parcels of farmland sold between Jan. 1, 2016 and Dec. 31, 2020. 48% of them have size ≤ 660 m²
- **Create other variables by using GIS maps.**

Number of approval cases of solar panels (in each month)



Monthly farmland price over time



Sample statistics of the variables

		Full sample	Treat=1 & Post=1	Treat=1 & Post=0	Treat=0 & Post=1	Treat=0 & Post=0	Uncon. DiD	
Variable	Definition	Mean	Mean	Mean	Mean	Mean		
Price	Price of the farmland (NT million/hectare).	95.09	96.02	124.85	81.28	67.78	-42.32	***
Land size	Size of the farmland (hectare).	0.09	0.03	0.03	0.15	0.14	-0.01	
City farmland	If a city farmland (=1).	0.58	0.1	0.74	0.04	0.49	-0.19	***
Productivity	Land productivity (1-10).	2.65	2.25	2.56	2.43	2.76	0.02	
Dis_association	Distance to the nearest farm association (kilometer).	2.98	3.67	2.79	3.71	3.08	0.3	**
Dis_highway	Distance to the nearest highway (kilometer).	7.91	9.9	6.85	9.4	8.73	2.3	***
Dis_road	Distance to the nearest road (kilometer).	1.38	1.16	1.35	1.43	1.42	-0.2	**
Covid	Number of daily Covid confirmed cases.	4.09	34.37	2.06	33.68	2.39	1.0	*
N	Number of farmland parcels.	30,290	635	13,917	1,140	14,598	81	

Econometric Model

- The baseline model is the difference-in-differences model
 - treatment group: farmland <660 m²; control group (>=660 m²).
 - timing of policy implementation (July 7, 2020).

$$\log(P_{ijmd}) = \alpha + \gamma_1 \times (T_{ijmd} * D_{ijmd}) + \gamma_2 \times T_{ijmd} + \gamma_3 \times D_{ijmd} + \beta' X_{ijmd} + u_j + u_{y*m} + \varepsilon_{ijmd}$$

i: parcel of farmland; j: township; year y, month m, and date d. T is the binary indicator whose value is one for the post-policy period. D is the treatment. X is explanatory variables. u_j and u_{y*m} are township and year-month specific fixed effects.

Main Results

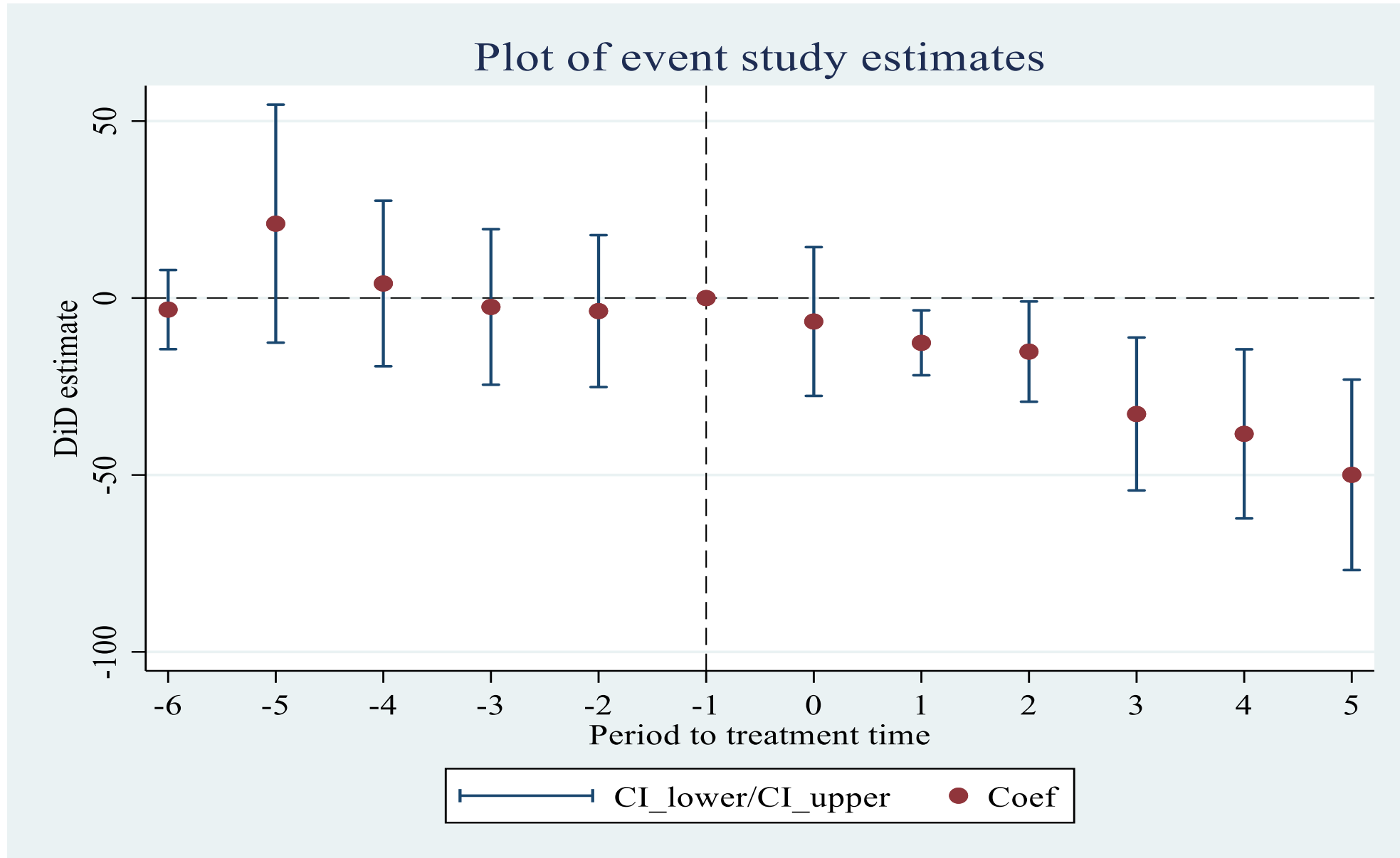
Table 3. Estimation results of the farmland price equation.

	Model A	Model B	Model C	Model D	Model E
Variable	Coef.	Coef.	Coef.	Coef.	Coef.
Treat*Post	-42.32***	-29.09***	-28.76***	-27.27***	-27.24***
%#1	-33.9%	-23.3%	-23.0%	-21.8%	-21.8%
Treat	57.07***	14.26***	14.38***	9.33***	9.41***
Post	13.5	27.87***	14.5**	15.3***	11.5***
Constant	67.78***	95.65***	78.65	112.73***	106.06***
Other variables	Yes	Yes	Yes	Yes	Yes
Year*month FE	No	No	Yes	No	Yes
Township FE	No	No	No	Yes	Yes
Adjusted R ²	0.073	0.21	0.219	0.586	0.587
N	30,290	30,290	30,290	30,290	30,290

DiD - Event Study Model

$$\log(P_{ijt}) = \alpha + \sum_{Pre=-6}^{-2} \gamma_{Pre} \times (Pre^* D_{ijt}) + \sum_{Post=0}^6 \gamma_{Post} \times (Post^* D_{ijt}) + \gamma_{\Delta} \times D_{ijt} \\ + \beta' X_{ijt} + u_j + u_{y+m} + \varepsilon_{ijt}$$

Results of the Event Study Analysis



Summary of Findings

- The tightened zoning regulation for solar panel installations led the price of affected farmland fall by 21.8%.
- The policy-induced fall in farmland price is only significantly in rural, but not urban. This may reflect option values of the farmland.
- Price decrease is smallest for farmland of high productivity. This may reflect high-productivity land can generate a potential higher value from farm production.
- Price decrease started two months after the policy's implementation and the magnitude of price fall escalated instead over time.

Future for Farm Sustainability

Key components to be considered:

- Digital Technology
- Big Data
- ESG (multi-field research work)

ICT and Rural Development

- The ICT can affect our life in many aspects.
- For people living in rural areas, this is particularly true. ICT can overcome the territory barrier of the rural households, and increase their access to better information and knowledge.
- Education inequality
 - Economic inequality
 - Health inequality
 - Intergenerational inequality

2019 OECD Rural Development Conference



HOME

PROGRAMME

DOCUMENTS

SPEAKERS

BACKGROUND

The Conference

 24-26 September 2019 | Seoul, Korea

The 12th OECD Rural Development Conference shared leading practices from across the world on how rural policies can support rural business to embrace new technologies and access global markets, deliver services and amenities in new ways, and mobilise rural assets (renewable energy, natural resources, land and know-how) to create jobs.

The conference took place over two days, followed by an optional field trip to nearby Wanju in Jeonbuk Province to demonstrate local approaches to rural development and well-being.

Watch the video of the conference highlights [▶](#)



Main theme: How to use ICT to improve rural development and wellbeing of rural residents?

What is Big Data?

- 4V: Volume; Velocity; Variety; Veracity
- Non-Structural Data Source
- Population Representative

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Clipboard: Paste, Cut, Copy, Format Painter

Font: Calibri, 11, Bold, Italic, Underline, Text Color, Background Color

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Cells: Insert, Delete, Format

Editing: AutoSum, Fill, Clear, Sort & Filter, Find & Select

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB
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4	103	\$ 8,641.73	13	F																								
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6	105	\$79,923.36	12	M																								
7	106	\$57,007.00	14	M																								
8	107	\$59,494.84	15	F																								
9	108	\$92,150.41	13	M																								
10	109	\$75,373.30	13	F																								
11	110	\$15,680.30	13	M																								
12	111	\$46,593.41	13	F																								
13	112	\$71,386.71	15	M																								
14	113	\$72,674.96	11	M																								
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17	116	\$99,265.27	14	M																								
18	117	\$46,181.11	11	F																								
19	118	\$74,175.59	15	M																								
20	119	\$73,409.86	11	F																								
21	120	\$65,784.26	14	M																								
22	121	\$ 3,532.26	14	M																								
23	122	\$33,836.95	15	M																								
24	123	\$56,806.58	13	F																								
25	124	\$68,478.31	13	M																								
26	125	\$60,566.22	15	F																								
27	126	\$98,447.41	13	F																								
28	127	\$79,397.90	11	F																								
29	128	\$17,594.75	12	F																								
30	129	\$84,667.93	13	M																								
31	130	\$87,953.71	13	M																								
32	131	\$68,423.74	14	F																								
33	132	\$51,357.62	13	M																								
34	133	\$82,233.86	12	F																								
35	134	\$92,901.91	14	M																								
36	135	\$75,153.35	13	M																								
37	136	\$29,740.94	15	M																								
38	137	\$ 795.36	13	F																								
39	138	\$27,283.46	12	M																								
40	139	\$ 1,137.37	12	F																								
41	140	\$61,127.80	13	M																								
42	141	\$33,153.06	12	F																								
43	142	\$19,774.73	15	M																								
44	143	\$55,925.97	13	M																								
45	144	\$25,598.81	15	M																								

絕佳採光景觀雙人床 西門町交誼空間 獨立衛浴 唐吉訶德電影街 I Play Inn 愛玩客

★ 4.64 (28 reviews) · [Wanhua District, Taipei, Taiwan](#)

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Show all photos

Private room in hostel hosted by I Play Inn

2 guests · 1 bedroom · 1 bed · 1 private bathroom



£15 / night

★ 4.64 (28 reviews)

● COVID-19

搜尋字詞



+ 比較

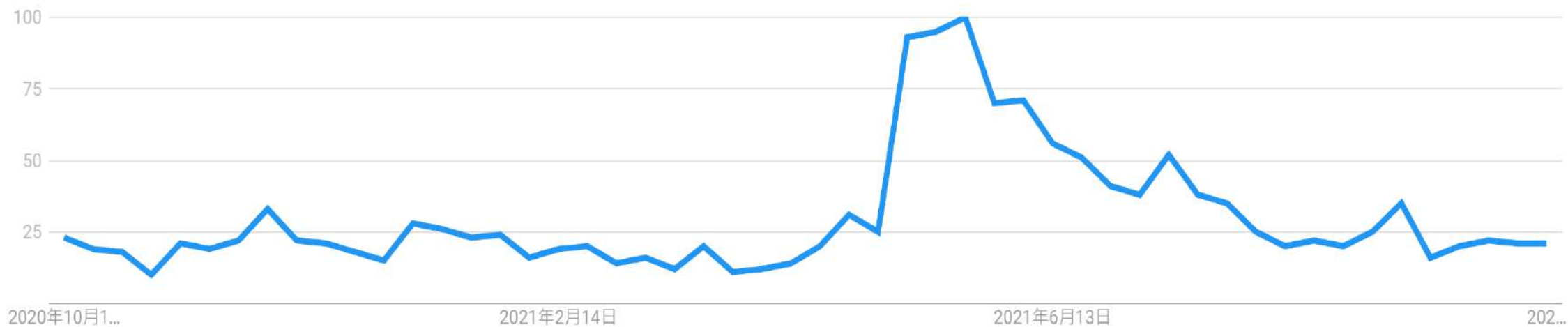
台灣 ▾

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搜尋熱度的趨勢變化 ?



Victoria Belle Spa

Page Messages Insights Posts Build Audience Help

Inbox ALL UNREAD UNANSWERED FLAGGED Search tags and messages

Select All AWAY Laine Gregory

Gabe Reilly 1:42pm
I'd like to book an appointment for Monday...

Laine Gregory 1:42pm
Hi! Can you help me book an appointment?

Sam Lee 1:42pm
Hi! Just following up regarding that message?

Alex Pak 1:42pm
Thanks for everything! It was great.

Ryan Ebanks 1:42pm
Which haircare products are you stocking now?

Meridith Blascovich 1:42pm
Hi! Have you posted your holiday hours?

Asher Rapkin 1:42pm
What's the best way to get to you by MUNI?

Karri Wane 1:42pm
Do you offer gift certificates?

Hi! Can you help me book a spa package?

Sure! I'd be more than happy to help. The last time you were here you did the two hour treatment. Would you like that same treatment again?

1:43 PM

Yep! That's the one!

Great - I will check on our availability right now!

Thanks!

Sent by Laine Rhodes at 1:43 PM

Sent by Laine Rhodes at 1:43 PM

Laine Gregory

About View Profile

- Local time is 1:30pm
- Liked since January 1, 2001
- Works at Jasper's Market
- Lives in Sunnyvale, California
- From Santa Clara, California

Keywords

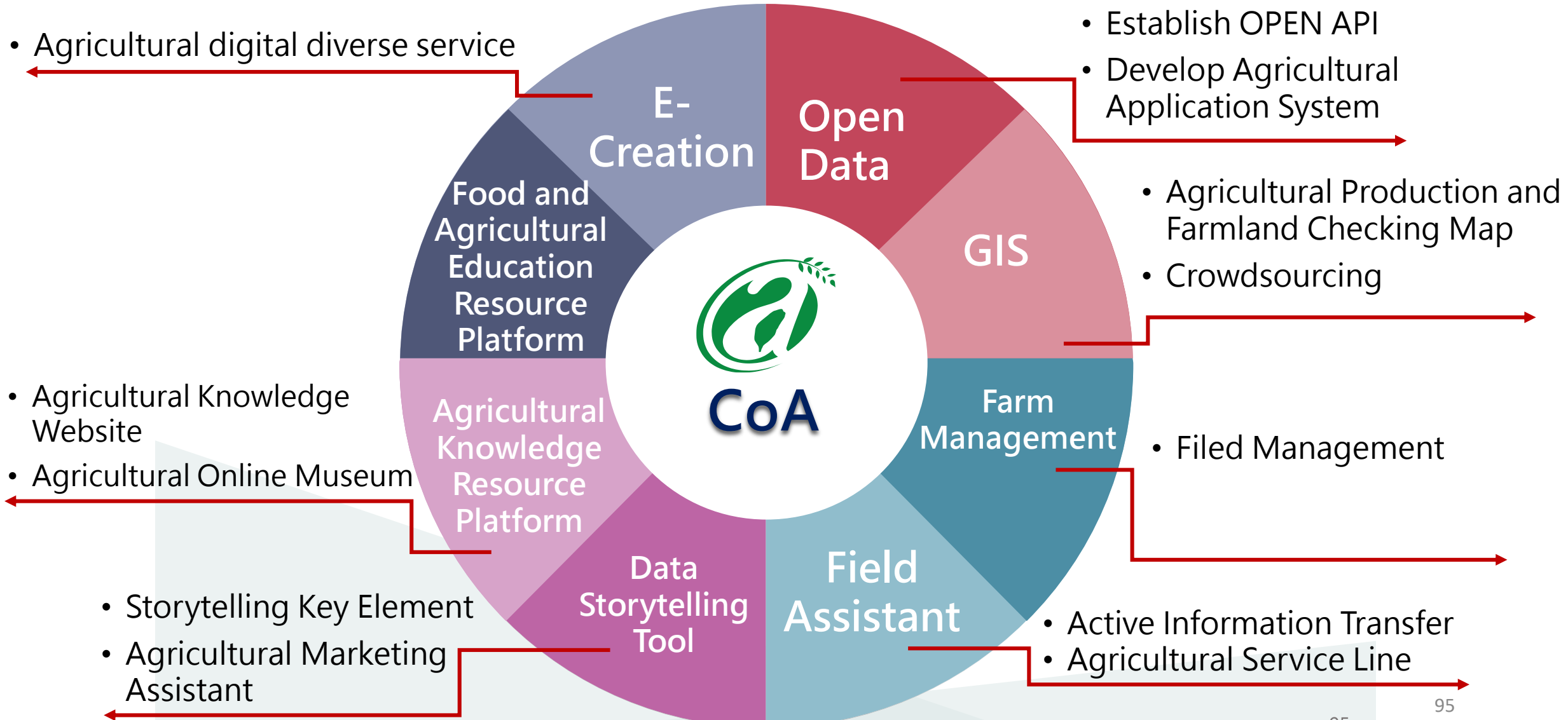
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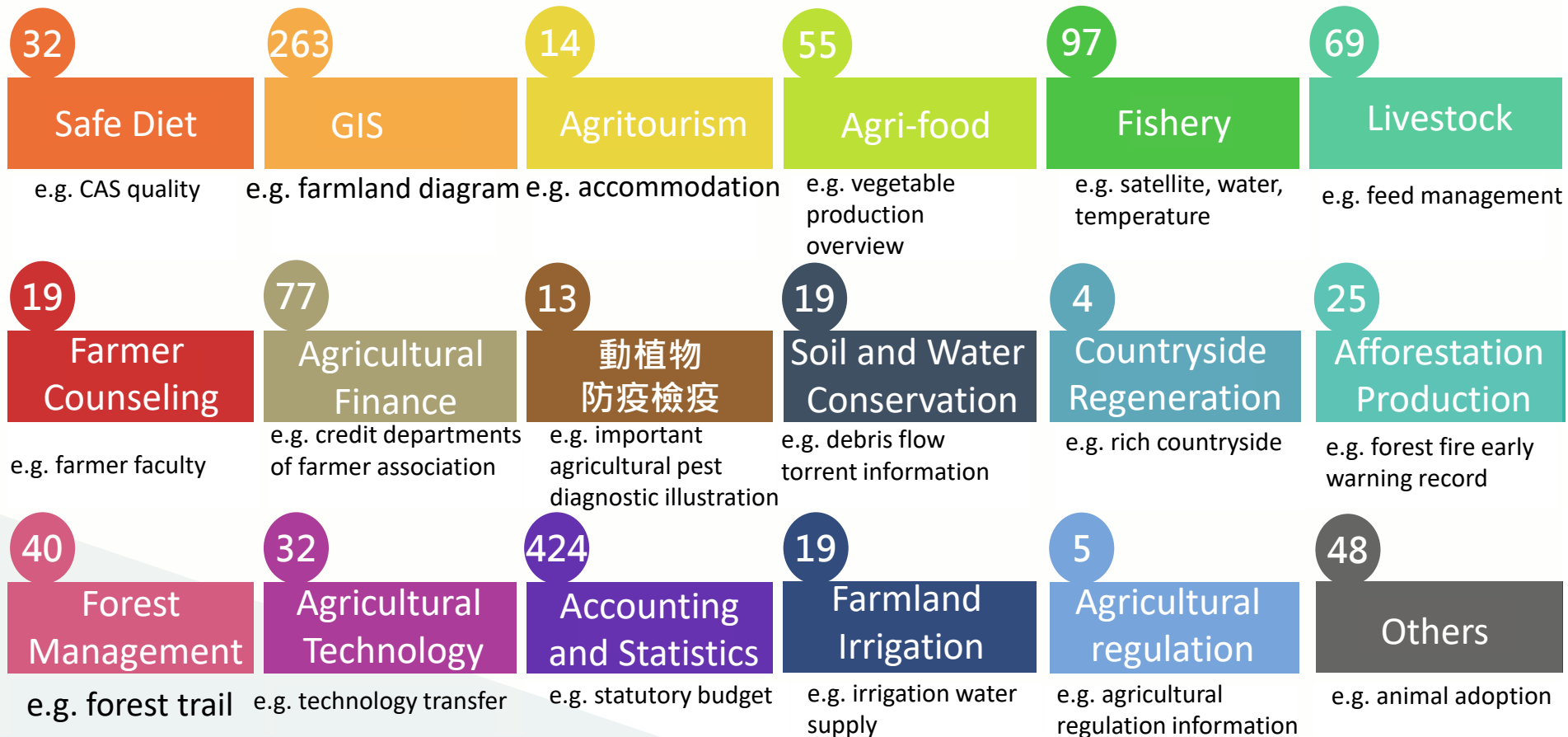
Big Data in Agriculture



Big Data in Agriculture

Website of open data

<http://data.coa.gov.tw>



In total, **18** category · **1300** item

Agriculture GIS of Farmland



In 2018, farmland use is categorized into 35 items and 13 types

Conclusion

- Short of farm labor is observed in many countries.
 - old age farm structure
 - attract young farmers to agriculture
- Importance of digital agriculture
- Recognize the importance of natural resource in farm sustainability
- Let the Food Market Work

An aerial photograph of a lush green landscape. The foreground and middle ground are dominated by terraced agricultural fields, likely rice paddies, which are filled with vibrant green crops. The fields are separated by narrow, winding paths and small channels. In the lower-left quadrant, there is a dense, dark green forest. A small, simple wooden structure is visible in the middle ground, nestled among the fields. The overall scene is a beautiful representation of rural agricultural land.

**Thank you
for your attention**