

Taiwan Agricultural Technology Foresight 2025

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Dr. Julie C. L. SUN Biotechnology Industry Study Centre Taiwan Institute of Economic Research

The Agriculture in Taiwan

Taiwan, with nominal GDP \$427 billion dollars and GDP (PPP) per capita \$35 thousand dollars in 2010, is famous for its manufacturing capabilities. Taiwan was one of the leading countries in subtropical agriculture several decades ago, but now agriculture has lost its importance in job creation, domestic production and international trade. However, agriculture is still at the root of the economy and has many functions beyond production - it provides the food we eat, conserves the environment we live in, and is a force for social stability.

In order to revitalize agriculture sector to meet the challenges of trade liberalization, globalization, the knowledge- based economy and particularly, climate change, the Taiwanese Government's Council of Agriculture (COA) commissioned a project- *Taiwan Agricultural Technology Foresight 2025* - to the Taiwan Institute of Economic Research (TIER). This four-year project (2008–2011), with an annual budget of USD 350 000, conducted foresight-related activities including demand surveys, trend and policy analyses, horizon scanning, visioning, essay contests, training workshops, two-round Delphi surveys, road mapping and development of policy suggestions (short-, mid-and long-term development plans and priorities). This paper is aimed to introduce the framework of the project and to analyse the major part of the project based on the expert opinion by large scale Delphi survey.



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Participants / Stakeholders



Framework of Taiwan Agricultural Technology Foresight 2025



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Taiwan Agricultural Technology Foresight 2025

- TIER set up a task force of 6 research staffs and 2 assistants from 2008. The task force learned the foresight techniques mainly from Japan, and built up the data base including social needs, technological trends, research resources, critical issues and agricultural policies nationwide and worldwide. Under the support and approval of COA, the project set up the **Planning Committee** of 17 members, including government officers, agricultural experts, senior research fellows, social scientists and one economist.
- The **Planning Committee** decided that the **target year** of the project is **2025**, and that the function of the foresight is to meet the long term objectives for agriculture in three aspects: Firstly, economically, to increase the productivity of the work force, to improve the efficiency in the use of farmland, to transform the industrial structure into knowledge-based economy, to reach sustainable growth and to keep international competitiveness; secondly, socially, to guarantee quality and safety of the product for consumer, to improve welfare for farmers and their families, to improve the quality of life in rural areas, to narrow the gap in living standards between urban and countryside; and thirdly, ecologically, to harmonize agriculture and the environment, to ensure sustainable use of agricultural resources, to maintain the nation's "green assets" and biodiversity.



(74 Research Topics

for Questionnaire)

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- In order to link the foresight and policy, the project set up the Strategy Formation Committee, divided by 10 sub-committees, corresponding to the 10 research areas of COA, each of which is comprised of 4 agricultural experts and senior scientists on average. The members of the Strategy Formation Committee are nominated by the Planning Committee and approved by COA. The duty of the Strategy Formation Committee is to depict 2025 scenario and to figure out the research topics to meet the long term objectives for agriculture in Taiwan.
- In 2009, the Strategy Formation Committee proposed more than 100 research topics for Taiwan Agricultural Technology Foresight 2025. TIER task force tried to adjust the research topics in a uniform format and to consolidate some of the research topics. Then the Planning Committee decided the final 74 research topics and the key questions (the impacts on industrial development, life quality, and environment protection, government support and importance) as the main part of Delphi questionnaire.
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Global Trend / Bibliometric Analysis Agriculture Related Strategy Formation

Socio-economic Needs Analysis

Scenario Writing

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Taiwan Agricultural Technology Foresight 2025

During this period of time between 2008 and 2010, TIER task force analysed social needs, technological trends, research resources, critical issues and agricultural policies nationwide and worldwide for both Committees as background information. TIER task force carried out the foresight activities such as demand survey, horizon scanning, scenario, bibliometrics, essays (competition), workshops, conferences, and forums. TIER task force also set up a platform, the website dedicated for Taiwan Agricultural Technology Foresight 2025, including on line Delphi Survey, and a database of more than three thousand experts and scientists in Taiwan. www.biotaiwan.org.tw

Methodology of Taiwan Agricultural Technology Foresight 2025



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観墳	1	2	3	4	5	關發表信對此間的建議與看法
 對提升民眾生活品質的影響力 對提升環境品質的影響力 對提升環境品質的影響力 對提升產業登買的影響力 對提升產業登買的影響力 和濃塑對於國家的重要度 		0000000				
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 對提升民眾生活品質的影響力 對提升環境品質的影響力 對提升產業登誤的影響力 對提升產業登誤的影響力 政府參與的必要程度 本議題對於國家的重要度 			000000		00000	
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Two Rounds of Delphi Survey

- In 2010 TIER task force executed two rounds of Delphi survey of Taiwan Agricultural Technology Foresight 2025. The first round investigated 675 experts and scientists, 546 of which participated (response rate 80%), and 512 of which questionnaire were effective. The academia, research institutes, industry, and government account for 69%, 21%, 6%, and 4% respectively. The male and the female account for 78% and 22%. The groups of age, above 60, between 46 and 59, between 30 and 45, below 29 account for 35%, 25%, 30%, and 10% respectively.
- The second round investigated 546 experts and scientists, 413 of which participated (response rate 76%), and 407 of which questionnaire were effective. The academia, research institutes, industry, and government account for 66%, 25%, 5%, and 4% respectively. The male and the female account for 81% and 19%. The groups of age, above 60, between 50 and 59, between 40 and 49, between 30 and 39, below 29 account for 15%, 37%, 36%, 11%, and 1% respectively.

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www.biotaiwan.org.tw **Survey Responses** 21% Female Male Business Government 78 Academia Research 69% 35% Aged under 29 ✓ **546** survey responses 30-45 years old ✓ **460** on line survey 46-59 years old \checkmark 538 to be invited to 2nd round 25% Aged over 60 \checkmark 512 effective responses Source: TIER(2010). The second round Delphi survey of Taiwan Agricultural Technology Foresight 2025 18 台灣經濟研究院 Taiwan Institute of Economic Research

Two Rounds of Delphi Survey

- Based on the survey responses (Likert scale rating 1-5) to 74 research topics, the project compiled the indices of industrial development, life quality, environment protection, national priority and government support to measure the research topics in different aspects. Particularly, the papers define national priority as industrial development, life quality, and environment protection, with equal weights according to COA policy. The standard deviations of all indices at the second round become smaller than those at the first round, so it implies that the Delphi survey of Taiwan Agricultural Technology Foresight 2025 did converge.
- What follows is to study the relationships between industrial development, life quality, environment protection, national priority and government support to be need for the 74 research topics of Taiwan Agricultural Technology Foresight 2025. The survey shows that the government should support those research topics with higher ratings in environment protection and in life quality due to externality. It is, however, slightly correlated between industrial development and government support to be need for those research topics because some of them could be developed by the private sector.

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Delphi Survey on Industrial Development

Establishment of rapid diagnosis systems for infectious diseases of livestock, poultry and aquatic animals (2)	90.00	y = 0.1	123x + 62.8	
Establishment of mass quality fry production technologies for grouper, shrimp, and other important fishes (1)	80.00		0.0237	
Improvement of integrated safety test, certification, traceability system for agri-food products (3)	60.00			
Improvement of high-quality seed and seedling production technology for the tropics and sub-tropics (4)	50.00			
Development of agricultural and livestock production systems with IT and automation technologies (7)	40.00			
Establishment of animal vaccine production systems that conform to international cGMP guidelines (6)	animal vaccine production systems that aligned and ali			
Development of efficient, labor-saving and safe facilities and technologies for agricultural production and processing operations (5)	20.00			
Incentive development to foster a new generation of farmers and entrepreneurial management (10)	0.00			
Construction of whole-plant orchid export system (8)	0.00	20.00	40.00 政府參與	
Development of crop production systems with low-energy consumption, low emission of greenhouse gases, and efficient use of water resources (12)	Go Note: () T Source: TI of Taiwan	bvernm he rankin ER(2010 Agricultu	ent Sup g of the fi), The sec ral Techn	

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Delphi Survey on Life Quality

Top 10

Top 10

Development of accurate, rapid and simple diagnostic kits for pesticide residues (1)
Improvement of integrated safety test, certification, traceability system for agri-food products (2)
Elucidation on the transmission mode and pathogenic mechanism of animal and human infectious diseases (3)
Improvement of forecasting and monitoring techniques for slopeland debris slides (5)
Research on ecological restoration of polluted farmland, derelict rearing pond, overdrawn groundwater area, river bed and bank, and degraded forestland (4)
Promotion of recreational agriculture and rural development that integrate health, culture, leisure and nature conservation (7)
Elucidation of global climate change affecting Taiwan's agricultural ecosystem and development of countermeasures (9)
Development of food-safety monitoring system and inspection techniques (6)
Establishment of database and diagnostic techniques for toxic substances in agricultural materials and products (10)
Construction of rural and urban linkages for quality living system (8)



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www.biotaiwan.org.tw **Delphi Survey on Environment Protection** Top 10 100.000 y = 1.0733x - 11.71 Research on ecological restoration of polluted farmland, $R^2 = 0.6521$ 90.000 derelict rearing pond, overdrawn groundwater area, river bed and bank, and degraded forestland (1) 80.000 Development of groundwater-saving aquaculture (3) Improvement of forecasting and monitoring techniques for 70.000 slopeland debris slides (2) Development of crop production systems with low-energy 60.000 consumption, low emission of greenhouse gases, and efficient Ð use of water resources (4) 50.000 Elucidation of global climate change affecting Taiwan's agricultural ecosystem and development of countermeasures (5) Ē 40.000 Development of agricultural environmental-resources monitoring and disaster early-warning technology (6) 30.000 Integration of agricultural byproducts and refuses utilization systems and efficient energy conversion technologies (7) 20.000 Development of accurate, rapid and simple diagnostic kits for pesticide residues (8) 10.000 Research and development on ecoforestry and 0.000 biodiversification (9) 20.00 40.00 60.00 80.00 100.00 0.00 政府參與必要性 Development of energy-saving and carbon-reducing Government Support to be needed preservation and shipping technologies of agricultural and Note: () The ranking of the first round. processing products (12) Source: TIER(2010), The second round Delphi survey 台灣經濟研究院 Taiwan Institute of Economic Research

www.biotaiwan.org.tw **Delphi Survey on National Priority** 90.00 y = 0.6065x + 23.831Development of accurate, rapid and simple diagnostic kits for $R^2 = 0.6075$ pesticide residues (2) 80.00 Research on ecological restoration of polluted farmland, derelict rearing pond, overdrawn groundwater area, river bed and bank, 70.00 and degraded forestland (1) Elucidation of global climate change affecting Taiwan's 60.00 agricultural ecosystem and development of countermeasures (4)

Improvement of integrated safety test, certification, traceability system for agri-food products (3) Development of crop production systems with low-energy

consumption, low emission of greenhouse gases, and efficient use of water resources (5)

Improvement of forecasting and monitoring techniques for slopeland debris slides (6)

Development of groundwater-saving aquaculture (7)

Development of agricultural environmental-resources monitoring and disaster early-warning technology (8)

Development of energy-saving and carbon-reducing preservation and shipping technologies of agricultural and processing products (9)

Elucidation on the transmission mode and pathogenic mechanism of animal and human infectious diseases (10)

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Delphi Survey on www.biotaiwan.org.tw

Government Support to be needed

Top 10

Improvement of forecasting and monitoring techniques for slopeland debris slides (1)

Research on ecological restoration of polluted farmland, derelict rearing pond, overdrawn groundwater area, river bed and bank, and degraded forestland (2)

Elucidation of global climate change affecting Taiwan's agricultural ecosystem and development of countermeasures (3)

Development of agricultural environmental-resources monitoring and disaster early-warning technology (4)

Development of groundwater-saving aquaculture (5)

Elucidation on the transmission mode and pathogenic mechanism of animal and human infectious diseases (6)

Collection and conservation of genetic resources in the face of climate change (7)

Improvement of integrated safety test, certification, traceability system for agri-food products (8)

Development of water system design and basin assessment techniques for irrigation and environment-regulation functions (10)

Establishment of transformation guidelines and impact assessment for sustainable farm land development (9)

Note: () The ranking of the first round.

Source: TIER(2010), The second round Delphi survey of Taiwan Agricultural Technology Foresight 2025 台灣經濟研究院 Taiwan Institute of Economic Research

Conclusions

- This was the first time that Taiwan conducted a large-scale expert opinion survey using the Delphi approach, in order to identify the research topics to meet the needs for shaping the future agriculture in Taiwan. The project made policy suggestions by road mapping at the end of 2011, and these have been incorporated into COA's research agenda as evidenced by COA's R&D system call-for-projects announcement.
- The major contribution of the project has been the Government's support for the research topics of 'national priority' in terms of industrial development, environmental protection and life quality, with equal weights embedded in the vision of making a better living in Taiwan. The project is expected to improve farmers' productivity and livelihoods, particularly for smallholders; to develop resource-efficient and environmentally-friendly ways to do farming in Taiwan's limited land area; to reinforce the links between production and consumption of agricultural products by implementing a traceability system.

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