Taiwan Agricultural Technology Foresight 2025

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July, 2012

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.

Basic Premises

- Long term perspective
- Demand orientation
- National well-being
- Knowledge based
- Integration of primary, manufacturing, and service Industries

The Purposes

- Consensus building
- Guiding strategic visions
- Mid-long term planning
- Communication and networking
- Supporting Decision-making system

Transition from traditional agriculture to technology-based agribusiness
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.
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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.

The Content of Delphi Survey

- Global Trend / Bibliometric Analysis
- **Agriculture Related Strategy Formation** (74 Research Topics for Questionnaire)
- Socio-economic Needs Analysis
- Scenario Writing

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- 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.

Methodology of Taiwan Agricultural Technology Foresight 2025

Survey on line
Taiwan Agricultural Technology Foresight 2025

Website: http://agritech-foresight.coa.gov.tw/

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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Survey Responses

- 546 survey responses
- 460 on line survey
- 538 to be invited to 2nd round
- 512 effective responses

Source: TIER(2010), The second round Delphi survey of Taiwan Agricultural Technology Foresight 2025

- 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.
## Delphi Survey on Industrial Development

### Top 10

1. Establishment of rapid diagnosis systems for infectious diseases of livestock, poultry, and aquatic animals (2)
2. Development of agricultural production systems with high-quality seed and seedling production technology for the tropics and subtropics (3)
3. Establishment of animal vaccine production systems that conform to international cGMP guidelines (4)
4. Development of efficient, labor-saving, and safe facilities and technologies for agricultural production and processing operations (5)
5. Incentive development to foster a new generation of farmers and entrepreneurial management (6)
6. Construction of whole-plant orchid export system (7)
7. Development of crop production systems with low-energy consumption, low emission of greenhouse gases, and efficient use of water resources (8)
8. Research on ecological restoration of polluted farmland, derelict rearing pond, overdrawn groundwater area, river bed and bank, and degraded forestland (9)
9. Development of forecasting and monitoring techniques for slopeland debris slides (10)
10. Development of agricultural environmental-resources monitoring and disaster early-warning technology (11)

### Notes:
- The ranking of the first round.
- Source: TIER(2010), The second round Delphi survey of Taiwan Agricultural Technology Foresight 2025

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## Delphi Survey on Life Quality

### Top 10

1. Development of accurate, rapid, and simple diagnostic kits for pesticide residues (1)
2. Elucidation on the transmission mode and pathogenic mechanism of animal and human infectious diseases (2)
3. Improvement of forecasting and monitoring techniques for slopeland debris slides (3)
4. Development of groundwater-saving aquaculture (4)
5. Establishment of database and diagnostic techniques for toxic substances in agricultural materials and products (5)
6. Development of food-safety monitoring system and inspection techniques (6)
7. Establishment of agricultural environmental-resources monitoring and disaster early-warning technology (7)
8. Development of energy-saving and carbon-reducing preservation and shipping technologies of agricultural and processing products (8)
9. Research on ecological restoration of polluted farmland, derelict rearing pond, overdrawn groundwater area, river bed and bank, and degraded forestland (9)
10. Development of energy-saving and carbon-reducing preservation and shipping technologies of agricultural and processing products (10)

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## Delphi Survey on Environment Protection

### Top 10

1. Research on ecological restoration of polluted farmland, derelict rearing pond, overdrawn groundwater area, river bed and bank, and degraded forestland (1)
2. Development of crop production systems with low-energy consumption, low emission of greenhouse gases, and efficient use of water resources (2)
3. Elucidation of global climate change affecting Taiwan's agricultural ecosystem and development of countermeasures (3)
4. Improvement of forecasting and monitoring techniques for slopeland debris slides (4)
5. Development of groundwater-saving aquaculture (5)
6. Development of agricultural environmental-resources monitoring and disaster early-warning technology (6)
7. Integration of agricultural byproducts and refuses utilization systems and efficient energy conversion technologies (7)
8. Development of accurate, rapid, and simple diagnostic kits for pesticide residues (8)
9. Research and development on ecoforestry and biodiversification (9)
10. Development of energy-saving and carbon-reducing preservation and shipping technologies of agricultural and processing products (10)

### Notes:
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## Delphi Survey on National Priority

### Top 10

1. Development of accurate, rapid, and simple diagnostic kits for pesticide residues (1)
2. Research on ecological restoration of polluted farmland, derelict rearing pond, overdrawn groundwater area, river bed and bank, and degraded forestland (2)
3. Elucidation of global climate change affecting Taiwan's agricultural ecosystem and development of countermeasures (3)
4. Improvement of integrated safety test, certification, traceability system for agri-food products (4)
5. Development of energy-saving and carbon-reducing preservation and shipping technologies of agricultural and processing products (5)
6. Establishment of database and diagnostic techniques for toxic substances in agricultural materials and products (6)
7. Development of food-safety monitoring system and inspection techniques (7)
8. Establishment of database and diagnostic techniques for toxic substances in agricultural materials and products (8)
9. Research on ecological restoration of polluted farmland, derelict rearing pond, overdrawn groundwater area, river bed and bank, and degraded forestland (9)
10. Development of energy-saving and carbon-reducing preservation and shipping technologies of agricultural and processing products (10)

### Notes:
- The ranking of the first round.
- Source: TIER(2010), The second round Delphi survey of Taiwan Agricultural Technology Foresight 2025

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Delphi Survey on www.biotaiwan.org.tw

Government Support to be needed

Top 10

<table>
<thead>
<tr>
<th>Research Area</th>
<th>Rank</th>
</tr>
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<tbody>
<tr>
<td>Improvement of forecasting and monitoring techniques for slopeland debris slides</td>
<td>(1)</td>
</tr>
<tr>
<td>Research on ecological restoration of polluted farmland, derelict rearing pond, overdrawn groundwater area, river bed and bank, and degraded forestland</td>
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<td>(6)</td>
</tr>
<tr>
<td>Collection and conservation of genetic resources in the face of climate change</td>
<td>(7)</td>
</tr>
<tr>
<td>Improvement of integrated safety test, certification, traceability system for agri-food products</td>
<td>(8)</td>
</tr>
<tr>
<td>Development of water system design and basin assessment techniques for irrigation and environment-regulation functions</td>
<td>(9)</td>
</tr>
<tr>
<td>Establishment of transformation guidelines and impact assessment for sustainable farm land development</td>
<td>(10)</td>
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Source: TIER(2010), The second round Delphi survey of Taiwan Agricultural Technology Foresight 2025

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 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.

Evaluation / Impact

- Setting research directions by identifying national needs
- Building networks around a common vision
- Extending the breadth of knowledge
- Bring new actors into the strategic debate
- Improving policy-making and strategy formation

Top winners of the Taiwan Agricultural Technology Foresight 2025 contest: