Strategy of Agricultural Technology Commercialization from Governmental Research Institutions to the Public in Taiwan: An International Perspective

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ABSTRACT

Modern agricultural research outcomes include: plant breeder's rights, patents, copyrights, trade secrets, etc. This report describes the common international methods used in agricultural technology commercialization, in comparison with the strategy carried out in Taiwan for transferring technology from governmental institutions to the public. More than 80% of our agricultural R & D outcomes were provided free to domestic farmers and part of the technologies with commercial potential were transferred to private agricultural enterprises or individuals through a paid authorized system. It could not only accelerate the speed and efficiency of dissemination, but also created new industries. To implement this package strategy effectively, a complete set of regulations and related managing systems should be set in advance.

Keywords: Breeder, compost, machinery, propagation, rights, seeds, transfer

INTRODUCTION

In most Asian countries, including Taiwan, the agricultural system is mostly small-scale. The average farmland owned by a farmer is usually one hectare or less, farmers are economically disadvantaged and have difficulty to develop their own technology. Therefore agricultural researches are mainly carried out by government institutions, financed by the government, and the outcomes are transferred directly to farmers free of charge. This policy has been accepted and executed for years in most countries. Now agriculture has to face a number of global challenges including climate change, free economic trade, the diversity of consumer demand, the innovation of technology and the intellectual economy, etc. To maintain the competition for sustainable development, our agricultural policy has to be changed from conservative or defense type to offensive type.

Modern agricultural research outcomes and technologies include: plant breeder's rights, patents, trademarks, copyrights, trade secrets, etc. (Sun *et al.*, 2014). In the past, technology had played an important role for both agricultural productivity and the economical success of many

agribusinesses (Boehlje, 2004). Agricultural technology and commercialization are important stimulators for the rural economy (Von Braun, 1995). Some agricultural technologies have great commercial potential, how to make full use of the technology and resources to promote industrial innovation and strengthen the competitiveness of our agriculture has become an important issue.

CONVENTIONAL METHOD OF TRANSFERRING AGRICULTURAL TECHNOLOGY IN TAIWAN

Most of the agricultural research programs are conducted in government institutions in Taiwan, including agricultural research institutes, stations, universities and colleges. In general, the universities and colleges are responsible for fundamental research, and the governmental institutes and stations are responsible for applied research.

Under the Council of Agriculture (COA), there are seven District Agricultural Research and Extension Stations (DARES), together with two professional Stations (one for tea and one for crop seeds). Disseminating agricultural technology to farmers is a major task of the governmental Stations. Traditionally, transferring of agricultural technology was executed by the governmental agencies, and was free of charge. And the government has to finance the agricultural extension activities every year.

It was estimated that more than 80% of our agricultural R & D outcomes were provided free to domestic farmers, which include: crop cultivation techniques, pest and disease diagnosis and control techniques, soil diagnostics and fertilization techniques. The new techniques were disseminated to the farmers through a variety of methods such as the three-stage propagation (**TSP**) system, field demonstrations, workshops, seminars, and farmer's training courses. The TSP system had created a huge rice seedling propagation industry, contract farming center, which is also a successful model of commercialization.

Rice varieties released are free from government institutions to farmers

Rice is the most important food crop in Taiwan. Based on food security reasons, the government should provide sufficient registered seeds for rice growers. Because most of the rice breeding programs are carried out by government institutions, the institutions should be responsible for providing good rice varieties with good quality and high yield potential.

To transfer a new crop variety to the farmers, a three-stage propagation (TSP) system had been established and conducted for many years in Taiwan. TSP system has shown to be highly efficient for rice crops.

The first stage is the production of breeder's seeds. Since breeder's seeds are the most fundamental seeds, any mistake is not allowed. The central governmental breeding institutes are responsible for producing the breeder's seeds. To keep the purity and quality of each variety, the producing fields should be set up inside the Stations. The second stage is the production of fundamental seeds. The local County Governments are responsible for this matter and have to set

up the producing fields. The third stage is the production of the registered seeds. The local County Governments would authorize honorable farmers to set up producing fields.

For example, rice variety Taichung 192 (TC192) was named and released by Taichung DARES in 2007. This variety was selected, after a series of experiments, from a cross between varieties Taiken 14 and Taiken 8 in 2001. TC192 possesses the following characters: moderate resistance to brown plant-hopper and smaller brown plant-hopper, with high yield potential, good appearance quality, and good eating quality. TC192 became very popular after it was released.

In the first year, Taichung DARES had set up a field, 0.06 hectare, in the Station's farm and produced 220 kg of breeder's seeds. In the second season, the local governments including Taichung, Chunghua, Chiayi, Yunlin, and Hualien Counties got these seeds, and set up many propagation fields, about 2.9 hectares in honorable farmer's farms, and produced about 14,210 kg of fundamental seeds. In the third season, the rice seedling producing centers got these seeds, and set up many producing fields, about 196 hectares, and produced 962,800 kg registered seeds. Rice farmers have to buy the registered seeds for their own cultivation. Thereafter the total cultivation area of TC192 was 13,088 hectares in the third year. The TSP system had created a huge rice seedling propagation industry, the producing centers, which is also a successful model of commercialization.

New technologies are disseminated free from government institutions to farmers

The main method for disseminating new technical information and knowledge to farmers is to set up demonstration fields in farmer's farm. During harvesting or a specific time, the research institutions would hold a meeting or a workshop, and call for neighborhood farmers to observe the results. Once the farmers are satisfied with the results, the new technology could be transferred to them directly.

Besides, the technical knowledge can be disseminated through seminars or farmers' training courses. The agricultural technology training courses are organized by people from the Council of Agriculture and the District Agricultural Research and Extension Stations who are responsible for teaching and practical training. Each Agricultural Research and Extension Station has built up a farmer's database, and the connection between Station and farmers is quite intense. Every year, the agricultural institutions publish many technical reports and brochures, which would be sent to related farmers free of charge.

THE STRATEGY OF AGRICULTURE TECHNOLOGY COMMERCIALIZATION IN TAIWAN

Policy changed from free of charge to paid authorized system

Modern agricultural research outcomes and technologies include: plant breeder's rights, patents, trademarks, copyrights, manufactured methods, trade secrets, etc. They are considered to be

intellectual property rights at present.

After the Fundamental Science and Technology Act were promulgated in Taiwan in 1999, all intellectual property rights (IPRs) arising from government-funded research projects and not designated national property were conferred upon the organization responsible for the projects. Due to the nature of the property, the IPRs should be protected, managed and utilized by the relevant institutions.

Therefore, the government policy has to be changed accordingly, with the development of intellectual economy, and parts of the agricultural technology with commercial potential were asked to transfer to private enterprises or individuals through a paid authorized system. This is because cooperation with private sectors could not only accelerate the speed and efficiency of dissemination, but also create new industries.

The strategies of technology commercialization were described by Chen *et al*. (2014) as follow:

1. Establish a complete regulation and management system;
2. Establish a technology commercialization platform;
3. Strengthen the cooperation of cross-cutting R&D;
4. Set up agricultural innovation incubators; and
5. Assist agricultural business management and financial intermediations.

After the regulations and management system were completed, the number of cases and amount of COA technology transfer increased significantly year after year. The first year, 2002, had only 3 cases with a total amount of about US$. 39,000. In 2013 there were 127 cases with a total amount of about US$. 2.8 million. It ranked second among all of the ministries implementing scientific R&D projects (Chen *et al*., 2014).

The establishment of regulations and related managing systems

According to the Fundamental Science and Technology Act article 12, the central government is to establish a National Science and Technology Development Fund. The Fund is managed by the Ministry of Science and Technology at present.

According to article 13, the income earned by the research organizations, arising from IPRs and the results of scientific R&D projects shall be appropriated to the Fund for safekeeping and use. The fund was used to subsidize scientific R&D projects, and encourage related researches. According to the regulations, for example in governmental institutions, 60% of the income was appropriated to the Fund, and 40% was assigned to the related researchers.

Plant breeder's right is one of IPRs. In order to protect it, the first edition of 'Plant Seed Act' was promulgated and enacted in 1988, and it had been amended six times during the last 28 years. The last amended version was completed and promulgated as 'Plant Variety and Seed Act' in 2004. This Act is enacted to protect plant variety rights, facilitate improvements in plant varieties, and implement a plant seed administration system in order to promote farmers' interests and benefit agricultural development.

The plant variety right is not automatically enforced for all the plant species. It was regulated in Article 4 that seed plants, ferns, and other plants designated as botanical taxons as governed by this Act should be proclaimed by the central competent authority. That means only the plant species that were reviewed and proclaimed by the government are possible to have the rights. There are 176 plant species been proclaimed until 2016, including 55 vegetables, 70 flowers, 35 fruit trees, three food crops, one forestry plant, two mushrooms, and 10 other plant species.

All the application of plant breeder's rights should be submitted to the Agriculture and Food Agency (AFA). AFA is an agency under COA.

There are three patents involved in agricultural technology: invention patent; utility patent; and trademark. The approval of invention patent needs substantive examination and takes longer time. Utility patent needs only document examination, and takes about six months.

All the application of patents and trademarks should be submitted to Taiwan Intellectual Property Office (TIPO). TIPO is an agency under the Ministry of Economic Affairs (MOEA).

To fulfill the regulations of the Fundamental Science and Technology Act, COA helped establish systems on promoting R&D outcomes and implement performance-based funding measures to encourage organizations and researchers to file for patents, technology transfers, and copyrights.

COA had promulgated a rule, Directions for the Implementing of Academic- Industrial Cooperation Program, to promote the cooperative behaviors in 1998. In 2001, COA promulgated another rule, Regulations for the Possession and Employment of Scientific Research Outcomes, to regulate the behavior of agriculture technology transfers (Council of Agriculture, 2011). These efforts have helped expedite the application of R&D outcomes.

Under the administrative guidance of COA, an Agricultural Intellectual Property Rights Committee (IPRC) was setup since 2002. All the technology transferring cases, plan to transfer to the public for commercialization, should be submitted to this committee to get the permission. Before submitting to IPRC, all the transferring cases should be accessed and evaluated by the related Institutions.

COMMERCIALIZATION OF AGRICULTURAL TECHNOLOGY: CURRENT STATUS IN TAICHUNG DARES

The main agricultural research outcomes and technologies selected for commercialization in Taichung DARES were limited to plant breeder's rights, patents and trade secrets, due to the preference of the private sectors. The methods, procedures and results were exemplified as followings.

Commercialization of new crop varieties: plant breeder's right

Taichung DARES had bred and named various plant varieties every year, but not all were applied for plant breeder's rights. There were 17 certificates of plant breeder's rights obtained by this

Station in the last five years (Table 1.), which include rice, chrysanthemum, *Dendrobium* and *Oncidium* orchid, cabbage, snap bean, pea, grape and mango. Varieties with commercialized potential were released through technical transferring model to the public.

Because the station owns the producing and promoting rights of those varieties, if one variety that was evaluated has commercial potential, then the station may choose to go through the paid authorized system to release it to the public.

For example cabbage variety Taichung No. 2 is an F1 hybrid, characterized with heat tolerant, good quality and high yield potential was released in 2013 (Hsiao, 2013). After field demonstrations, this variety was accepted to be a good variety for summer production in the low land. Since the production of hybrid seeds need delicate techniques and skillful workers, it was not easy to work with general farmers. Hence, it was selected to be a good item for commercialization.

The producing right was authorized exclusively to a private company with high price (about US$ 89,000). After hybrid seeds were sold to the farmers, the cultivation area increased quickly. The total cultivation area was 235 ha in between 2014 and 2016, and it had resulted in a total output value of about US$ 4.7 million.

It seems that commercialization process worked smoothly through this system. The governmental institute focused on breeding works, and the private company was responsible for producing and commercializing works. The farmers can have the opportunity to buy their favorite seeds conveniently. The plant breeder's right was effectively protected by both government and private company as well.

Table 1. Number of plant breeder's rights certificates obtained by Taichung DARES during the last 5 years [z].

Year	Crop	Name of the variety	Certificate number
2011	Chinese kale	Taichung No.1	A01075
2012	Chrysanthemum	Taichung No.6	A01268
	Oncidium	Taichung No.2	A01271
2013	Snap bean	Taichung No.5	A00795
	Chrysanthemum	Taichung No.7	A01546
	Chrysanthemum	Taichung No.8	A01547
	Grape	Taichung No.4	A01496
	Pea	Taichung No.16	A00883
	Oncidium	Taichung No.3	A01355
	Cabbage	Taichung No.2	A01432
2014	Mango	Taichung No.1	A01706
	Dendrobium	Taichung No.1	A01597
	Dendrobium	Taichung No.2	A01598
	Dendrobium	Taichung No.3	A01599
2015	Cymbidium	Taichung No.1	A01540
	Grape	Taichung No.5	A01860
	Rice	Taichung No.194	A01103

[z] Taichung DARES Annual Report 2011, 2012, 2013, 2014, and 2015.

Commercialization of Bio-compost producing technologies: patents and methods

Taichung DARES had focused on the research and development of bio-compost, bio-pesticide and microbial fertilizer for more than 20 years. Kuo *et al*. (2014) reported that in recent 10 years, researchers of this station had screened many domestic microbial strains with the potential for making bio-fertilizers or bio-pesticides. There are 12 invention patents obtained by this station in the last 10 years (Table 2). The content of these patents include new microbial strains such as: *Trichoderma*, *Bacillus* and *Actinomycetes*, together with microbe preparation methods, and biological compost making techniques. These strains were proven to have excellent capability to break down organic matters, and the composting process can be shortened too. Using these strains, together with special cultural methods, a variety of biological compost, organic fertilizer and compost nutrient could be developed. Therefore, these technologies have the commercial potential, and the related products can help to increase the yield and quality of crops.

The patents, together with utilization techniques, were transferred to private companies by the Station, and the products were commercialized by the companies as well. The major products

are biological compost, liquid fertilizers, growth media and substrates (Table 3).

This is a successful commercialization model for agricultural technology. Although the farmers could make bio-compost by themselves, the higher cost and long time consume should be taken into account.

Table 2. List of invention patents, obtained by Taichung DARES[z] in recent 10 years, which are related to the technology transfer for making bio-compost.

Item	Patent name	Certificate Number
1	Method for producing utility model of biological compost	I 229064
2	Rice grain medium and microbe preparation method thereof	I 273134
3	*Trichoderma spp*. strain for making biological rice husk compost	I 287534
4	*Trichoderma spp*. strain for making biological sugarcane residue / wood chip compost	I 287535
5	*Trichoderma spp*. strain for making cattle dung compost	I 295686
6	Method for accumulating maturity of biological compost and its application	I 298715
7	Rice grain medium and microbe preparation method thereof	I 306448
8	The vegetables and fruit medium culture and its preparation method thereof	I 309552
9	*Bacillus subtilis* strain for making biological compost	I 312366
10	*Bacillus subtilis* strain for making biological compost	I 326305
11	The king oyster mushroom culture medium preparation method thereof and it contained the novel *Trichoderma spp.* strain	I 378143
12	The compost and it contained the *Actinomycetes* strain	I 424978

[z] Taichung District Agricultural Research and Extension Station, Council of Agriculture.

Table 3. The transfer and commercialization of bio-compost producing technologies carried out by Taichung DARES[z] in recent 10 years.

Item	Basic materials	Microbial strains	Transferred company	Name of products
1	Sugar cane waste and used sawdust compost	*Trichoderma asperellum*, *Bacillus amyloliquefaciens*	Fwusow Industrial Co. Ltd.	Nature basic fertilizer
2	Pure microorganism culture	*Trichoderma asperellum, Bacillus amyliliquefaciens*	Fwusow Industrial Co. Ltd.	FS-BIO-2
3	Family food waste	*Trichoderma asperellum*	Taichung District Farmers' Association	Kitchen Waste Compost Strain
4	Cattle dung	*Trichoderma asperellum*	Xi De Bio-Technology Co. Ltd.	Cattle Dung Compost 301 and TCT301
5	Cattle and chicken dung, soybean waste	*Trichoderma spp., Bacillus subtilis*	Garden Field Bio-Technology Company	Garden Field No.1 and No.3
6	Liquid soybean extract	*Trichoderma spp., Bacillus subtilis*	Whole Nature Agriculture Biotech Co. Ltd.	Pearl Organic Fertilizer
7	Mushroom sawdust compost waste	*Trichoderma spp., Bacillus subtilis*	Mei Chia Agricultural Product Co. Ltd.	Organic Fertilizer
8	Organic materials	*Trichoderma asperellum*	Jin Xin Long Trading Co. Ltd.	Efficient Organic Fertilizer and *Trichoderma* TCT111
9	Mushroom sawdust compost waste	*Trichoderma asperellum*	Jin Yu Bio-Technology Farm	Organic Fertilizer
10	Cattle dung	*Trichoderma asperellum*	Tian Luo Co. Ltd.	Feng Tian No.1 Organic Fertilizer
11	Biological compost	*Bacillus amyloliquefaciens*	Green Generation Biotech Co. Ltd.	Green Generation No. 1
12	Biological Materials	*Streptomyces spp.*	Pin Fu Fa Biotech Co. Ltd.	In developing
13	Biological Materials	*Trichoderma spp.*	Taiwan Agricultural Biotechnology Co., Ltd	Fenggen Organic Liquid Fertilizer
14	Soybean flour and protein extracts	*Bacillus amyloliquefaciens*	Pin Fu Wang Co. Ltd	Pin Fu Wang No. 22

[z] Taichung District Agricultural Research and Extension Station, Council of Agriculture.

Commercialization of agricultural machinery: manufactured method

Compared to crop researches, the agricultural machinery research is more like mechanical industry. The ordinary used big agricultural machines like tractors, tillers, harvesters, seeders, mowers, etc. are manufactured by international agricultural machinery manufacturers. The governmental research units can only make or improve small machineries.

Tien *et al*. (2008) reported that an electronic self-propelled lifting carrier had been developed by the researchers of Taichung DARES. This new machine was designed to be used for managing, harvesting and carrying crops in the greenhouse. It is a front-wheel steering and rear-wheel driving electronic self-propelled lifting carrier, and was powered by a 950W DC motor. Two 24V batteries in parallel made this carrier able to operate about 2-4 days after they have been fully charged. The lifting of the working deck was powered by hydraulic system. The maximum lifting height was 800 mm with lifting capacity of 200 kg. The testing results of operation speed showed that the machine is over three times higher than labor in performance.

This carrier design received a Utility Patent (M295135) in Taiwan, ROC in 2006, and had been authorized to two machinery companies for commercialization in 2006.

The operation of this carrier is simple, which can move backward and forward, turning and lifting the working deck, etc., and proved to be a good tool for greenhouse cultivation. It became popular after sold to the greenhouse growers. Until 2014, there were 206 carriers that were sold with a total commercial value of about US$ 600 thousand (Tien *et al.*, 2015).

OVERSEAS AUTHORIZATION AND INTERNATIONAL PERSPECTIVE

In principle, technology transfer is limited to the domestic industry in Taiwan, however, to expand to international trade, overseas authorization is also feasible, but it must be carefully assessed, and should be approved by COA in advance.

Lee *et al*. (2015) reported that there are four preconditions needed while submitting overseas authorization including: 1) no prejudice to the national security or public interest; 2) no adverse effects on our agricultural industry or economic development; 3) no violation of the relevant provisions of the law or international agreement; and 4) should be agreed by the Council of Agriculture.

Before approving for overseas authorization by COA, four principles should be promised: 1) meet the fairness, openness, and efficiency; 2) has clear business model, and/or a complete assessment of operational planning; 3) the risk can be controlled; and 4) mainly opened for our citizens.

Therefore, technologies suitable for transferring overseas have to consider the maximized benefits as following: 1) favor to international layout; 2) promote agricultural competitiveness; 3) large number of imported products; 4) the technique has limited or no development, or new technique had been developed; 5) after announcement no one will undertake the technique; and 6) international cooperation program results.

The Council of Agriculture started to promote overseas authorization of R & D outcomes since 2004. Until the end of May 2015, the Agriculture Intellectual Property Rights Committee had received 47 applications, 41 of them were approved, and 29 of them signed the authorization contracts, which including 21 plant varieties and eight technique authorizations. The total amount of technical transfer for overseas authorization was about US$ 2.14 million in this period.

The designated countries or regions to implement the authorized technologies, from the

above mentioned 29 overseas authorization cases, which include Japan 16, China 8, Hong Kong 1, other Asian countries 8, United States and Canada 3, Europe 4, Global 7, and southern hemisphere region 2.

A successful case of overseas authorization for plant variety: Vegetable soybean

Vegetable soybean is an export-oriented crop in Taiwan. About 20 years ago, due to low price competition with China, Indonesia, Thailand, and Vietnam, Taiwan had gradually lost the Japanese market. In order to regain it back, COA has initiated a plan to cooperate with the Taiwan Regional Association of Frozen Vegetable and Fruit Manufactures (in brief, Frozen Association) and Kaohsiung District Agricultural Research and Extension Station (Kaohsiung DARES). Frozen Association is responsible for making contract cultivation with domestic farmers, and executing export affairs with foreign markets. Kaohsiung DARES is responsible for supplying good soybean varieties suitable for target markets.

To protect plant breeder's right and contract farmer's interests, Kaohsiung DARES went to Japan to apply plant breeder's right for new soybean varieties Kaohsiung No. 6, 7, 8, and 9. Meanwhile Kaohsiung DARES started to promote an overseas authorization project in 2008. In 2009, the four varieties producing rights were authorized to Snow Brand Seed Co., Ltd. Japan. These actions had effectively protected the bilateral rights against the illegal reproduction form other countries.

By working together with those three parties, the Taiwan vegetable soybean industry regain the Japanese markets gradually, the exported quantity was increased year after year, and has occupied about 44% of Japanese market. In 2014, the total amount was 33,717 metric tons, worth about US$ 71.92 million and reached the highest record for the last 21 years.

It showed that vegetable soybean sold to the international markets had greatly enhanced the competitiveness of the domestic industry, attracting six processing companies back to Taiwan to expand their factories and built a new factory with the investment of about US$ 60 million, creating thousands of jobs, and also increased the annual salary for the professional soybean farmers.

The establishment of Agricultural Biotechnology Park and Agricultural Technology Research Institute

To accelerate the progress of internationalization and commercialization, COA had established a Ping-tung Agricultural Biotechnology Park (PABP) in 2003 and an Agricultural Technology Research Institute (ATRI) in 2014, which will gradually lead agricultural technology to promote the economic developments in the future.

PABP provide lands for rent, infrastructure systems, public facilities, and administrative services for the agribusiness and industrial companies. Up to now, the Park has approved the residency applications of 98 agricultural and biotechnology enterprises.

The missions of ATRI are to commercialize agricultural technologies, to provide assistance to private sectors in strengthening competitiveness and promoting international markets, and to work collaboratively with research institutes to develop innovative technologies.

Under the supervising of ATRI, there is an Industrial Development Center (IDC) which is set up to provide services for both governmental institutions and private sectors. The objectives for IDC are to provide a platform to integration technologies, business planning of commercialization, industrialization, and promotion of new agribusiness. In addition to providing information on current developments and investment opportunities of agribusiness in Taiwan, the platform also effectively connects farmers with potential new business in charting out the best business model in order to establish sustainable cooperation and maximize the mutual and social benefits.

CONCLUSION

The commercialization of agricultural technology can help to promote the transformation of agriculture, and is beneficial for promoting the national economy. It has shown that technology commercialization system has been carried out smoothly and successfully in the past 10 years in Taiwan. The governmental institutions had the courage to take the first step, and had created many successful stories in the domestic markets. On the other hand, the overseas authorization still has less successful cases up till now, which shall be promoted in the future. For long term development, the related laws and regulations should be completed, with sufficient financial support and international connections.

REFERENCES

Boehlje, M. 2004. Business challenges in commercialization of agricultural technology. *International Food and Agribusiness Management Review* 7(1):91-104.

Chen, R.R., H.H. Lee, and H.S. Lur. 2014. Current status and prospects of agricultural technology R&D results: The commercialization. *Agriculture Policy & Review* 266:8-13.

Council of Agriculture. 2011. *Compilation of Agricultural technology R&D Results Management Regulations*. 234pp. Published by Industrial Technology Research Institute, Taipei. (in Chinese)

Kuo, C.C., C.W. Chen, Y.F. Tsai, and C.T. Liao. 2014. The recent research and development outcomes of Taichung DARES. *Quarterly Agricultural Information of Taichung DARES* 87:23-26. (in Chinese).

Hsiao, C.H. 2013. Cabbage variety Taichung No. 2. *Taichung DARES Newsletter* 83:10. (in Chinese)

Lee, H.H., C.W. Kuo, Z.T. Chen, and R.R.Chen. 2015. Current status and prospects of agricultural technology R&D results: Overseas authorization. *Agriculture Policy & Review* 278:23-30. (in Chinese)

Sun, C.L., M.S. Jhou, Y.T.Yang, and Y.C. Liu. 2014. The strategy of authorization and commercialization for plant seeds intellectual property right. p. 171-204. In: Sun C.L. (ed.). *The Establishment of New Value Chain for Agriculture II: From the Industrial Point of View to Think about the Strategy of Our National Agriculture Development*. Taiwan Institute of Economic Research published. (In Chinese)

TDARES. 2012. *Taichung DARES Annual Reports 2011*. 76pp. (in Chinese)

TDARES. 2013. *Taichung DARES Annual Reports 2012*.132pp. (in Chinese)

TDARES. 2014. *Taichung DARES Annual Reports 2013*. 116pp. (in Chinese)

TDARES. 2015. *Taichung DARES Annual Reports 2014*. 132pp. (in Chinese)

TDARES. 2016. *Taichung DARES Annual Reports 2015*. 136pp. (in Chinese)

Tien, Y.S., H.C. Chang, L.H. Chen, and J.H. Ho. 2008. Development of the electric self-propelled lifting carrier. *Bulletin of Taichung DARES* 99:11-22. (In Chinese with an English abstract).

Tien, Y.S., L.H. Chen, and C.Y. Chang. 2015. The largest promoting quantity of R & D results: Electric self-propelled lifting carrier. p. 81-83. In: Chang H.C (eds.) *Special Issue to Commemorate the 30th Anniversary Move for Taichung DARES*. (In Chinese).

Von Braun J. 1995. Agricultural commercialization: impacts on income and nutrition and implications for policy. *Food Policy* 20(3): 187-202.

Webpages

Agricultural Technology Research Institute. http://www.atri.org.tw

Agriculture and Food Agency. http://www.afa.gov.tw/laws_index.aspx?CatID=53

New AgriBusiness Development and Service. http://abds.atri.org.tw/en/about.html

Ping-tung Agricultural Biotechnology Park. http://www.pabp.gov.tw/indextempEng.asp

Taichung DARES. http://www.tdais.gov.tw/show_monthly.php?id=tdares_tdares_subadmin_20080526141247

Submitted as a resource paper for the FFTC –MARDI International Workshop on *"Effective IP Protection and Commercialization Strategies for Agricultural Innovation",* Oct. 18-20, MARDI Headquaters, Serdang, Selangor, Malaysia