

Chapter 21

Business Models for Plant Factory With Artificial Lighting (PFAL) in Taiwan

Wei Fang

Abstract Plant factory with artificial lighting (PFAL) is an emerging industry in Taiwan and attracting much attention. The number of companies involved in PFAL operations has increased from fewer than 10 to more than 100 in the past 5 years. Unlike traditional agricultural systems, PFALs can eliminate almost all the risks in production, although profitability cannot be guaranteed unless the business model is properly designed and implemented. This chapter focuses on introducing business models currently utilized in Taiwan.

Keywords PFAL • Business model • Taiwan

21.1 Introduction

Plant factory with artificial lighting (PFAL) is an emerging industry in Taiwan, which has been booming since 2010. In 2010, only 1 University and 13 companies were involved in PFALs, as loosely defined at that time. The activities of at least 6 out of the 13 companies that were related to hydroponics in greenhouses are not strictly PFALs. By the end of 2015, 14 Universities and research institutes were undertaking PFAL research and 98 private companies were operating PFAL business in Taiwan.

PFAL is an attractive technology package. It is both new and relevant to consumers' environmental, health, and food safety concerns. Thanks to advances in technology, production risks can be significantly reduced, although profitability cannot always be guaranteed. In Japan, only 25–30% of PFALs are making profit (Kozai 2014) and in Taiwan is less than that for most of the PFALs in Taiwan are rather “fresh” in the industry. Currently, the number of companies involved is increasing rapidly in Taiwan, making the industry appear promising. However, without a proper business model, setting up a PFAL could still be a possible cash strap.

W. Fang (✉)

Department of Bio-Industrial Mechatronics Engineering, National Taiwan University, Taiwan, Republic of China

e-mail: weifang@ntu.edu.tw

21.2 Business Models

Various business models of PFAL are being utilized in Taiwan. The products can be plants themselves in the form of whole plants, loose leaves, or baby leaves. Product presentation is very important, including packaging in sealed soft plastic bags, soft plastic bags with air vents, or sealed hard plastic boxes. Different types of packaging convey different messages to consumers, for example, “this product does not need to be washed before eating” or “is just as safe as an item grown in a greenhouse or open field.” It is also important to emphasize vegetables that are locally grown, not imported. If dressings are provided with salad greens, they must be exceptionally tasty. Thoughtful design of packaging bags and boxes can make the purchasing experience more pleasant compared with that for traditional agricultural products.

Sales channels can be membership based, through websites, within individual companies, or in local communities. Sold by the third-party should be limited. It is clear that selling the products through supermarket chains (owned by others) can only be a temporary measure, since shelf-charge rates are generally high. Therefore, the business-to-consumer (B2C) is more advantageous than the business-to-business (B2B) model for PFAL products.

If a PFAL operation cannot sell all its fresh products, there are other options. One company in Taiwan developed more than ten types of processed items such as ice cream, egg rolls, bread, noodles, face masks, skin cleansers, etc. with vegetable additives. Nutritional supplements in juice, powder, and tablet forms are alternative products that may be priced differently depending on the ingredient added. For example, noodles supplemented with lettuce and with ice plant vary in cost.

Ice plants are a good example of PFAL innovation. They have a salty fruit taste (similar to wax apples). The saltiness can be adjusted via nutrient solutions. Products containing ice plant are currently sold at premium prices due to their novelty, and creative entrepreneurs have invented attractive recipes utilizing it, including ice cream desserts, juices, cocktails, duct breast, and wrapped ground shrimp. It can be marinated in liquor or red wine or given a smoked-pine flavor.

One construction company incorporated the PFAL concept in its plan for a community development to promote a green lifestyle. Each home will be equipped with an appliance to grow vegetables, and the community will have a service division providing seeds, seedlings, stock nutrient solutions, etc. to the residents.

Several companies focus on the development and sale of home appliance-style plant production units and indoor green walls for residential use. One produces aquaponics units for hobby gardeners and homeowners. PFALs with attached restaurants or stands selling organic products are another popular business model in Taiwan. Such shops are normally chain operations located within cities.

Most enterprises constructing PFALs for others have demonstration facilities for the education of potential customers. The most successful demonstration sites are on a scale of daily production of at least 100 plants, have been in stable operation for several months or longer, and have established sales channels. Unfortunately,

only a few companies have achieved these goals so far, which makes it difficult to convince the public to start their own PFALs.

Many PFAL businesses are providers of related hardware, such as light-emitting diodes (LEDs), clean rooms, air-conditioning and hydroponic systems, power supplies, and thermal insulation material. These companies generally start by building PFAL demonstration sites and learning to grow plants. Becoming a PFAL turnkey provider is a common goal.

To summarize, there are several distinct PFAL business models utilized in Taiwan (Fang 2014, 2015):

1. Some PFALs grow leafy greens for their own use, for example, restaurant owners and corporations providing fresh, safe, nutritious vegetables to their own customers and employees.
2. PFALs produce leafy greens for Internet customers and/or a membership. Some companies are flexible, even exchanging memberships with other health-related organizations such as yoga clubs. Members can shop at specific PFAL companies and dine in their chain restaurants at discounted prices.
3. PFALs both grow and sell vegetables and offer processed items containing them such as egg rolls, ice cream, bread, noodles, facial and skin care items, and nutritional supplements.
4. PFALs sell their leafy greens through organic chain stores.
5. PFALs entrepreneurs devise creative recipes showcasing the unique flavors of their leafy vegetables such as ice plants, rucola, and basil, mainly for direct sale to restaurants.
6. In a joint venture with construction companies, a service company was established to supply nutrient solutions, seeds, and seedlings to residents in newly built housing developments.
7. Appliance-style PFAL module providers work in collaboration with the construction industry.
8. Appliance-style PFAL module providers operate demonstration facilities.
9. Related hardware providers build PFAL demonstration rooms to sell their products, with the goal of becoming turnkey providers.
10. Related hardware providers build cargo container-style PFALs for transplant production.
11. PFAL turnkey builders and consultants may operate with or without PFAL demonstration rooms.
12. PFALs-related educational services are also viable businesses. In Japan and Taiwan, some consulting firms and universities offer short (half-day to 5-day) and long-term (50-day) workshops. National Taiwan University has offered 30-h courses twice yearly for five consecutive years, in which more than 500 people have been trained.
13. Some PFAL-related firms/foundations/associations organize technical tours domestically and/or internationally.
14. One PFAL turnkey provider works with a rental company that regards production facilities as equipment and therefore can be rental items. Companies

involved in plant production need less initial investment, and monthly rental fees are tax deductible, resulting in significantly more financial flexibility.

15. Some solar panel manufacturing companies rent the roofs of PFALs to install solar panels. The electricity generated is then sold to power companies.

Although PFALs in Taiwan are small in scale, they are flexible and innovative in adopting various business models. At present, some hold great promise, while others have failed. As in other emerging industries, even enterprises following the same business model may succeed or fail depending on a host of factors.

Hydroponics is a well-accepted technology academically and commercially. However, in Taiwan, it is still difficult to convince people that the technology is more than just safe. Books related to plant factory for academic usage (Fang 2011b, 2012) and for general public (Fang and Chen 2014) were published. Answers to 24 frequently asked questions on hydroponics and artificial light grown vegetables were published (Fang 2011a), but some continue to doubt the nutritive value of vegetables grown hydroponically and will not accept those not grown in the ground and/or not using solar light.

The hydroponic industry in Taiwan was booming from 1985 to 1990 for leafy green vegetable production using the nutrient-flow technique (NFT) or deep-flow technique (DFT) and for tomato and cucumber production using drip irrigation with rock wool. However, due to the low dissolved oxygen concentration and bacterial outbreaks in greenhouses during the hot season, the industry gradually faded from 1990 to 2010. With the current PFAL boom, companies involved in hydroponic-related businesses are coming back to life.

21.3 Conclusion

PFALs are booming worldwide. In Taiwan, with no financial and policy supports from the government, private companies are viewing this new industry with great interest. PFAL-related nonprofit organizations have been established to take advantage of horizontal and vertical connections, foster cooperation among companies, and promote business opportunities.

At present, no private agricultural organizations are involved in PFALs in Taiwan. Several farmers' associations considered converting their unused warehouses into PFALs, but finally dropped the idea. The high initial cost is the first concern for potential PFAL operators; difficulties in finding a sufficient number of quality workers and managers are another, at least currently. In addition to academic training in undergraduate and graduate schools, National Taiwan University also offers a 30-hr workshop twice annually. Although more than 550 have taken the workshops, fewer than 10% actually became involved in the PFAL business. Training of qualified managers and workers for the PFAL industry is an issue that must be dealt with to provide worldwide business opportunities.

To solve the high initial cost problem in the PFAL industry, working with rental companies is one possible solution. However, the design of production systems including multi-layer cultural benches, lighting, hydroponics, controls, air circulation, etc. must be integrated, similar to equipment used in manufacturing. The equipment itself can serve as collateral for start-up costs.

Many companies become involved in PFALs with the ultimate aim of taking advantage of the business opportunities of turnkey projects. However, some were unable to demonstrate that their systems could grow higher-quality plants efficiently. It is unfortunate that some enterprises consider PFALs an opportunity to generate quick profits, which has led to lawsuits and public confusion. The approximately ten international turnkey PFAL projects constructed by Taiwanese enterprises are all in PR China.

Some consumers still question the use of artificial lights and hydroponics to grow food. “Unnatural” chemicals have been a frequently cited complaint in the past 3–4 years. Greater public awareness of how PFALs can lessen food safety and environmental problems, and more frequent media coverage of their benefits, will help consumers learn about and appreciate the technologies involved, as well as increase their willingness to pay premium prices for PFAL products. Important tasks remaining are lowering costs, increasing value, and expanding the vegetable varieties grown. PFALs are expected to coexist with organic and traditional agriculture and will undoubtedly play a key role in urban agriculture in smart/intelligent cities.

References

- Fang W (2011a) Some remarks regarding plant factory. Agriculture extension booklet number 67. College of Bioresource and Agriculture, National Taiwan University (in traditional Chinese)
- Fang W (2011a) Total controlled plant factory. Harvest farm magazine, Taiwan (in traditional Chinese)
- Fang W (2012) Plant factory with artificial light. Harvest Farm Magazine, Taiwan (in traditional Chinese)
- Fang W (2014) Industrialization of plant factory in Taiwan. Invited lecture in the Proceedings of the Greenhouse Horticulture & Plant Factory Exhibition/Conference (GPEC), pp 131–181. Japan Protected Horticulture Association (in Japanese)
- Fang W (2015) Business models of plant factory in Taiwan. Invited lecture in the Proceedings of Plant Factory 2015: International Symposium on Role and Contribution of Plant Factory Technology and Indoor Vertical Farming to Urban Agriculture and Future Life. Institute of Plant Science and Biotechnology, Research Institute of Agriculture and Life Science, Seoul National University
- Fang W, Chen GS (2014) Plant factory—a new thought for the future. Grand Times Publisher, Taiwan (in traditional Chinese)
- Kozai T (2014) Topic and future perspectives of plant factory. Invited lecture in the Proceedings of Greenhouse Horticulture & Plant Factory Exhibition/Conference (GPEC), pp 63–96. Japan Protected Horticulture Association (in Japanese)