

Developing Agri-based Technopreneurs in the Academe: The Case of Two DOST-Funded Projects in the University of the Philippines Los Baños

Dinah Pura T. Depositario*, **Maritess B. Panabang**,
Normito R. Zapata Jr., **Nanette A. Aquino**, and **Laida J. Abarquez**

Department of Agribusiness Management, College of Economics and Management, University of the Philippines Los Baños, College 4031, Laguna, Philippines. *Corresponding author. Email: dinahpura@yahoo.com. Telephone/Fax: +63 49 536 2846.

Abstract

This paper assesses the outcome of two Department of Science and Technology (DOST)–funded projects geared towards promoting technopreneurship among students of the University of the Philippines Los Baños (UPLB). It describes the various technopreneurial trainings and other inputs under the Agriculture, Forestry, and Natural Resources (AFNR) project. Then, using an action research design, it documents and examines the experiences of twenty-six (26) student-technopreneurs who conducted start-up businesses for five months using three UPLB-developed technologies, with supplementary funds coming from the Philippine Council for Industry, Energy, and Emerging Technology Research and Development (PCIEERD-DOST). The study uses primary and secondary data from the student-technopreneurs, validated through key informant interviews, to gain insights into the process of running the start-ups, including the challenges encountered and lessons learned, and then evaluates their performance using three parameters, namely, financial performance, entrepreneurial competencies developed, and the number of businesses registered after the project. Results show that the student-technopreneurs under the high-end cheese and by-products track were the most financially successful, followed by those under the fruit juice and puree track. Those under the microbial rennet were the least successful. All of the participants reportedly gained personal entrepreneurial competencies, the most important of which being acquisition of technological know-how. On the overall, the two projects are assessed to be successful. Lastly, only seven registered their businesses as most perceived that their current production scale was too small to require business registration. The paper then provides future directions for research and recommendations on how to improve the conduct of similar projects based on the experiences of the participants and the insights from the project management team.

Keywords: agri-based technopreneurs; innovation; student-technopreneurs;

Acronyms:

- AdMU – Ateneo de Manila University
 ADSC – Animal and Dairy Science Cluster
 AFNR – Agriculture, Forestry and Natural Resources
 BSA – Bachelor of Science in Agriculture
 BSABM – Bachelor of Science in Agribusiness Management
 BSFT – Bachelor of Science in Food Technology
 CA – College of Agriculture
 CEM – College of Economics and Management
 CTTE – Center for Technology Transfer and Entrepreneurship
 DAM – Department of Agribusiness Management
 DOST – Department of Science and Technology
 DTRI – Dairy Training and Research Institute
 FDA – Food and Drug Administration
 FSC – Food Science Cluster
 HEIs – higher education institutions
 ICT – Information and Communication Technology
 IFST – Institute of Food Science and Technology
 PCAARRD-DOST – Philippine Council for Agriculture, Aquaculture and
 Natural Resources Research and Development
 PCASTRD-DOST – Philippine Council for Advanced Science and
 Technology Research and Development
 PCC – Philippine Carabao Center
 PCIEERD-DOST – Philippine Council for Industry, Energy and Emerging
 Technology Research and Development
 PECs – Personal Entrepreneurial Competencies
 PhP – Philippine peso
 R&D – research and development
 S&T – science and technology
 SUCs – state universities and colleges
 TLP – technopreneurial learning project
 TBI – Technology Business Incubation/Incubator
 UPLB – University of the Philippines Los Baños
 UPLB-BIOTECH – National Institute of Molecular Biology and Biotechnology
 UPLBFI – University of the Philippines Los Baños Foundation Inc.

Introduction

Technopreneurship is derived from the words *technology* and *entrepreneurship*. The word *technology* generally means the practical application of knowledge, such as those generated by science, to solve problems. On the other hand, the word *entrepreneurship* means the organization and management of an enterprise and attendant risks (Zimmerer et al., 2008). With these definitions in mind, one can define *technopreneurship* as the formation of a new business that involves high level of technology, such as information and communication technology (ICT), environment, energy, and biotechnology (Gonzales, 2008). What separates it from the traditional business operations is innovation: technopreneurship involves producing and processing innovative, high-value products or creating innovative systems to serve consumers. Because of this, technopreneurs are considered to be the country's future wealth creators and economy drivers.

However, technopreneurship is not prevalent in the country, even in the academe where most knowledge and technology generation takes place. Citing the case of the University of the Philippines Los Baños (UPLB), Nepomuceno (2008) noted that only 16% of its biotechnologies have been commercialized, either through licensing and marketing agreements between the university and corporate institutions. According to Gonzales (2007), this may be because technology-based enterprises are research and development (R&D) intensive, need to “jump the curve,” are high-risk and stressful undertakings, and exhibit low survival rates, among others. Furthermore, traditional entrepreneurs in the country lack certain qualities that are necessary for technopreneurship, such as innovativeness and differentiation (Madarang, 2007).

To address this gap and encourage technopreneurship, UPLB instituted the Technology Business Incubator (TBI), which was envisioned as “a hub for information and communication technology and agri-biotechnology” and was “expected to commercialize the technologies developed by faculty, researchers and students of the university” (Cruz and Comendador, 2010). The program is under the administration of UPLB's Center for Technology Transfer and Entrepreneurship (CTTE) and is supported by the Philippine Council for Advanced Science and Technology Research and Development (PCASTRD-DOST),* which is under the Department of Science and Technology (DOST), and InWent Capacity Building International, Germany.

For the TBI project to become sustainable, it needed a constant supply of business start-ups to nurture. Hence, in 2009, UPLB launched its Agriculture, Forestry and Natural Resources (AFNR) program entitled “Harnessing

* PCASTRD-DOST is now known as the Philippine Council for Industry, Energy and Emerging Technology Research and Development (PCIEERD-DOST).

UPLB's Capacity for Technopreneurship and Technology Commercialization: Key to Better Placed AFNR Graduates," which was also funded by the DOST and under the overall administration of the Philippine Council for Agriculture, Aquaculture and Natural Resources Research and Development (PCAARRD-DOST). The project was a response to the observed decline in enrolment in AFNR courses in higher education institutions (HEIs) and state universities and colleges (SUCs) and the rise of unemployment among its graduates. The project aimed to provide trainings and hands-on skills geared towards promoting an entrepreneurial mindset in UPLB and developing technopreneurs among its students, faculty, researchers, and alumni.

In 2010, the Philippine Council for Industry, Energy and Emerging Technology Research and Development (PCIEERD-DOST) provided funds for a complementary project entitled "Supporting Technopreneurial Start-ups of Students and Alumni under the UPLB AFNR Project: A Complementary Initiative to UPLB's Technology Business Incubation Project." The purpose of the project was to provide supplementary funds for the start-ups of selected participants of the trainings and put into practice the knowledge they gained.

The UPLB AFNR project, TBI program, and the PCIEERD-DOST-funded project are interrelated (Figure 1). With assistance for capacity building as well as learning environment improvement from the AFNR project and funding for the operations of the students' start-ups from PCIEERD-DOST, UPLB aims to commercialize its technologies by developing technopreneurs equipped with the necessary business and technical know-how and providing them with supplementary funding and basic support to transform their business proposals into actual businesses under the TBI.

This paper describes the outcome of the AFNR project and a PCIEERD-DOST-funded project by examining the various processes in setting up and managing the start-ups (i.e., trainings and other inputs and experiences during production and marketing) and documenting the challenges encountered and the learnings the participants gained from the experience. It also assesses the performance of the business start-ups based on three parameters: (1) financial performance, (2) entrepreneurial competencies developed, and (3) the number of businesses registered after the project. Finally, it provides future directions for research and recommendations on how to improve the conduct of similar projects based on the experiences of the participants and the insights from the project management team.

Materials and Methods

The study used the action research design. Action research is "learning by doing"—after identifying a problem (i.e., the need to promote

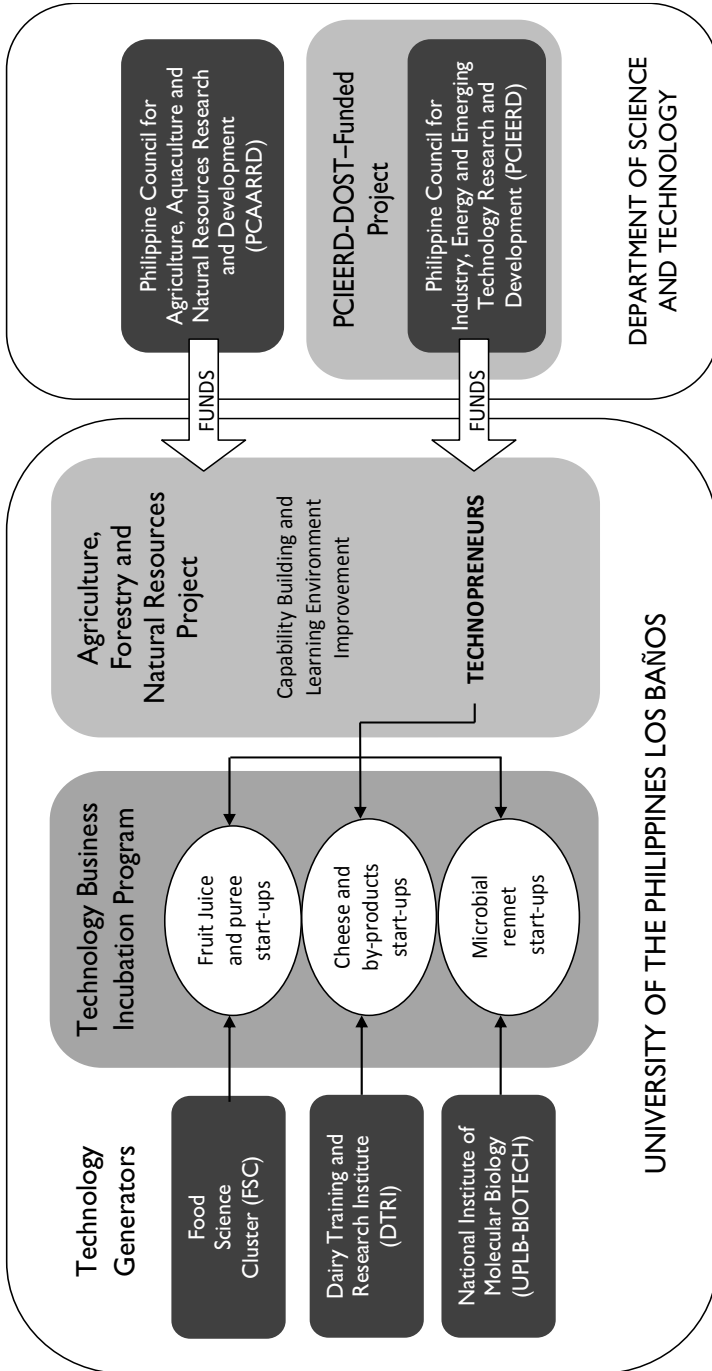


Figure 1. The model for the three interrelated projects

technopreneurship in UPLB), the researcher does something to resolve it (O'Brien, 1998). Since the participants were required to document their technopreneurial experience, the AFNR and PCIEERD-DOST project teams provided twenty-six student-technopreneurs with templates to gather data on the production process, sales per month, production runs per month, actual market, and registration of business start-up, among others, and track the performance of their start-ups. This became the source for primary data. The study also collected secondary data from progress reports and special problem reports submitted by the students during milestone periods and at the end of the project and analyzed these using frequency analysis and descriptive statistics, such as means and content analysis. The information gathered was validated through key informant interviews with the participants and inspection of the students' products, promotional materials, and other outputs.

Results and Discussion

Inputs

At the onset of the AFNR project, the project management team, in coordination with PCAARRD-DOST, identified mature technologies in UPLB that have high science and technology (S&T) content and good market potential. After careful deliberation, the team agreed that the project should focus on downstream processing, in particular food processing. The focus was decided to be on the following: high-end cheese and by-products processing, fruit juice and puree processing, and microbial-based rennet production.

Last 19 April to 8 May 2010, the Department of Agribusiness Management (DAM) of the College of Economics and Management (CEM) conducted the "Short Course on Technology-Based Entrepreneurship" as part of the AFNR project. The short course covered the whole process of basic entrepreneurship—from conceptualizing the business, marketing, and developing competencies to financing start-ups and business plan preparation. The short course was conducted in collaboration with the National Institute of Molecular Biology and Biotechnology (UPLB-BIOTECH) and the Food Science Cluster (FSC)—formerly the Institute of Food Science and Technology (IFST)—and the Animal and Dairy Science Cluster (ADSC) of the College of Agriculture (CA), which provided actual product and process demonstration to the participants. Graduating students from CEM and CA were invited to attend.

At the end of the short course, the participants were expected to come up with a business plan. Out of the sixty short course participants, thirty transformed their business plans into start-ups; but only twenty-six eventually proceeded to implement their start-ups. Among the participants, one (3.8%)

was from BS Agriculture (BSA) and five (19.2%) from BS Food Technology (BSFT), both under CA, and twenty (76.9%) were from BS Agribusiness Management (BSABM) under CEM. Depending on the technology that they intended to adopt for their business, the student-technopreneurs were classified under one of the three technopreneurial learning projects (TLPs).

Out of the twenty-six student-technopreneurs, seven (26.9%) were nurtured in the cheese processing laboratory of the Dairy Training and Research Institute (DTRI), and they produced either cream cheese, which used locally sourced ingredients—cow’s milk, goat’s milk, or a combination of milk from goat and carabao or water buffalo (*Bubalus bubalis carabanesis*)—or ricotta from cheese by-products (whey). Upon the recommendation of the technical mentors, the student-technopreneurs added flavors such as strawberry and blueberry to the cream cheese to add value. Though there were similar products available in the market, the ones produced were more healthful because they had less salt and fat content.

Meanwhile, fifteen (57.7%) student-technopreneurs were nurtured in the fruit juice processing plant of the Food Science Cluster (FSC), and they produced either ready-to-drink fruit juice or puree. To make their products unique, indigenous fruits—i.e., *calamansi* (*Citrofortunella microcarpa*), *dalandan* (*Citrus sinensis*), and *bignay* (*Antidesma bunius*)—were used as raw materials. Although it is not an indigenous fruit, the passion fruit (*Passiflora edulis*) was also used because juice drinks derived from it are not commonly available in the market. There were more students who engaged in fruit juice or puree processing due to the initial perception that a larger market for the product exists within and outside of UPLB. In addition, the process involved in fruit juice production was perceived to be less complex as compared to the other products.

Lastly, four (15.4%) student-technopreneurs were nurtured in the rennet manufacturing laboratory of UPLB-BIOTECH, and they produced microbial-based rennet in solid and liquid forms. The rennet in liquid form was suitable for direct buyers while the rennet in granulated or solid form was for online buyers. The solid form was more convenient to transport when sending products through courier service providers like LBC Express Inc. and it had a longer shelf life. Rennet is a substance containing the enzyme chymosin used in cheese production as a coagulant, which causes the milk to separate into curds (solids) and whey (liquid). Most local cheese producers use either ordinary vinegar or animal-based rennet from the stomach of cows. High levels of chymosin can be found in unweaned cows, but slaughtering these is not feasible in the country. Hence, producers are encouraged to use rennet from adult cows, which are known to produce less quantity and quality yield, or rely on imported ones.

UPLB-BIOTECH was able to produce rennet by using coconut paring meal to culture a fungus *Rhizopus chinensis*, which can be fermented to produce an enzyme similar to chymosin. The microbial rennet is 50% cheaper to use than animal rennet and is comparable to imported rennet in efficacy (Ricarte and Cruz, 2009). Among the three TLPs, the microbial rennet technology is the most complex and, because of this, attracted the fewest number of student-technopreneurs.

The student-technopreneurs under the project were expected to implement their business plans for five months with supplementary fund grant amounting to PHP 14,000 per student from PCIEERD-DOST. The project team facilitated the disbursement of funds through cash advances from UPLB Foundation Inc. (UPLBFI). The students were required to return all official receipts to the project team one week after the funds were disbursed, and these receipts were then used to liquidate the project team's cash advances. The project team maintained the individual student records of fund usage.

Aside from the fund grant, the student-technopreneurs received business development mentoring from selected faculty from DAM and technical mentoring from selected laboratory and plant staff of DTRI, FSC, and UPLB-BIOTECH. To monitor their progress, they also reported to the PCIEERD-DOST project team (who were also members of the AFNR project team), composed of three members of the DAM faculty, once every two weeks.

The student-technopreneurs received assistance in the following areas: (1) the sourcing of raw materials for containers (e.g., plastic bottles and tubs) and low-cost ingredients (e.g., fresh fruits, puree, or milk); (2) technical mentoring on laboratory techniques and protocols for proper handling, processing, and storage; (3) product formulation and improvement; (4) label and packaging improvement; and (5) market matching assistance through the provision of an initial list of customers and marketing outlets and of guidelines for negotiating with suppliers and potential customers and becoming intermediaries and dealers of the products.

Production

Each pre-identified TLP had its own production facility, which was used primarily for research and instruction: the fruit juice processing plant of FSC, the cheese laboratory in DTRI, and the microbial rennet laboratory in UPLB-BIOTECH. Though capable of commercial-scale production, these facilities were not fully utilized; hence, there were some opportunities to accommodate the participants. The laboratory equipment and production plants were upgraded under this project. All student-technopreneurs were required, as much as possible, to conduct their production runs in the laboratories in order to standardize production processes. The AFNR project management team facilitated the reservation of the facilities for this purpose.

For the initial production runs, the AFNR program provided the raw materials. Though the student-technopreneurs had their first production later than their target schedule due to delays in the release of funds, they were able to successfully conduct their production runs. The high-end cheese technological track had an average of 4.6 total number of production runs; the fruit juice/puree technological track, 2.8; and the microbial rennet track, 2.5 (Table 1). The cheese technopreneurs were able to process, on the average, two batches a month, the fruit juice and puree technopreneurs once a month, and the microbial rennet participants, once every two months. It took around 8 hours, on the average, to produce one batch of fruit juice and puree, about 1.5 days to produce cream cheese, and almost 2 weeks to produce microbial rennet. The average outputs of the students per production run were as follows: for ready-to-drink juice and puree, 250 pieces of 350-mL bottles; for ricotta and cream cheese, 40 pieces of 200-g tubs; and for the microbial rennet, 2.86 kg of granulated rennet or, if in liquid form, 5 L of rennet.

Almost all the student-technopreneurs, with two exceptions, exclusively availed of the toll processing services of the AFNR TLP plants and laboratories. The toll processing fee at the respective TLP plants and laboratories were as follows: PhP 1.50 per bottle for ready-to-drink juice and puree; PhP 10.00 per liter of milk-cream starter mixture for cream cheese; and PhP 600.00 per production run for microbial rennet. The toll processing fee covers the rentals for the equipment used as well as expenses for utilities. However, the student-technopreneurs still took an active part in the operation. In the case of juice processing, they were involved in cleaning and sanitizing the bottles and caps, labeling the finished products, and putting the products in boxes for storage in its designated area. In the case of cheese production, they were involved in the mixing and preheating, as well as the homogenization and pasteurization of the milk and cream; the addition of starter culture; the mixing of cream cheese and other ingredients; and the packaging of the final product, among others. Lastly, in the case of the microbial rennet production, they were involved in highly technical procedures such as the inoculation of bacteria, harvesting of culture growth, and separation of biomass from the culture broth through centrifugation.

Two of the student-technopreneurs under the high-end cheese track also opted to conduct some production runs at home using readily available kitchen tools. According to them, home-based production afforded them flexibility in scheduling their production runs and in producing the volume they desired. In terms of the number of home-based production runs, one student-technopreneur had seven while the other had four, an average of 5.5 production runs. The student-technopreneurs reported that there was no significant difference in the quality and yield of cheese produced in the laboratory and at home. Rather, the yield and quality improved as they performed more production runs.

Table 1. Summary of production runs, total sales, expenses, and net profit

Student no.	Course	No. of production runs	Total sales (PhP)	Total expenses (PhP)	Net profit (PhP)
High-end cheese and by-products					
Student 1	BSABM	5	8,200.00	7,857.00	343.00 ^b
Student 2	BSABM	2	4,055.00	3,825.00	230.00 ^b
Student 3	BSABM	7	19,145.00	18,585.50	559.50 ^b
Student 4	BSABM	7	2,630.00	2,933.75	(303.75) ^b
Student 5	BSABM	4	23,760.00	13,389.00	10,371.00 ^a
Student 6	BSA	4	10,930.00	7,337.00	3,593.00 ^b
Student 7	BSFT	3	25,875.00	14,500.13	11,374.87 ^a
Average		4.6	13,513.57	9,775.34	3,738.23
Ready-to-drink fruit juice and puree					
Student 8	BSABM	3	13,192.50	10,871.94	2,320.56 ^a
Student 9	BSABM	2	6,176.00	5,451.07	724.93 ^b
Student 10	BSFT	5	26,063.00	20,277.00	5,786.00 ^a
Student 11	BSABM	2	4,875.00	4,010.50	864.50 ^a
Student 12	BSABM	2	6,992.96	6,904.70	88.26 ^b
Student 13	BSABM	2	7,100.00	5,902.87	1,197.13 ^a
Student 14	BSABM	2	9,811.00	9,449.00	362.00 ^b
Student 15	BSABM	4	14,985.00	13,316.20	1,668.80 ^a
Student 16	BSABM	5	16,770.00	16,736.00	34.00 ^b
Student 17	BSABM	2	6,765.00	6,391.13	373.87 ^b
Student 18	BSABM	2	11,386.00	10,481.25	904.75 ^a
Student 19	BSABM	2	4,040.00	7,555.00	(3,515.00) ^b
Student 20	BSFT	3	21,005.00	14,785.30	6,219.70 ^a
Student 21	BSABM	3	6,234.00	12,233.00	(5,999.00) ^b
Student 22	BSFT	3	11,412.00	9,576.17	1,835.83 ^a
Average		2.8	11,120.50	10,262.74	857.75
Microbial rennet					
Student 23	BSABM	3	2,679.00	1,000.00	1,679.00 ^a
Student 24	BSABM	3	900.00	3,267.88	(2,367.88) ^b
Student 25	BSABM	2	0.00	3,197.41	(3,197.41) ^b
Student 26	BSABM	2	764.00	2,744.05	(1,980.05) ^b
Average		2.5	1,085.75	2,552.34	(1,466.59)

Note: ^a Equal to and greater than the mean; ^b Lower than the mean

Family support proved to be a plus factor in the technopreneurial enterprises. One of the student-technopreneurs claimed his father exerted a significant amount of effort as his assistant during his runs.

During the course of production, all the student-technopreneurs encountered some problems. In case of those under the cheese technology track, they encountered variability in the quantity and quality of yield. In consultation with technical mentors, the student-technopreneurs analyzed the fat content and acidity of the raw milk before processing to ensure that the right amount of cream was added. By trying out various milk-to-cream ratios, they were able to achieve the right formulation. In the case of fruit juice and puree technology track, the student-technopreneurs encountered product spoilage due to high pH of the juice, i.e., the formulation was sweeter than recommended. With the advice of technical mentors, the student-technopreneurs added citric acid to lower the pH and lessen the sugar content, as well as enforced stricter measures in inspecting raw materials and adherence to hygiene protocols in filling and capping bottles. They also experienced difficulties in scheduling their production as the students' schedule came in conflict with that of the processing laboratories, which are used for instruction and research. The only solution was the early reservation of the facility to avoid these conflicts and for the student-technopreneurs to maximize their time by engaging in marketing and promotional activities when the laboratories are unavailable. Both the fruit juice and cheese producers experienced difficulty in finding reliable and easily accessible suppliers of raw and packaging materials. Through referrals from mentors and Internet searches, they were able to address this problem. Lastly, in the case of the microbial rennet technological track, the student-technopreneurs experienced contamination of their inoculums, which was addressed by strictly following the prescribed procedure in processing.

Marketing

The technopreneurs improved their product labels as they received feedback from customers and mentors. The products under the various TLPs benefited from changing the font style, font size, layout, and background color of their labels. Other changes introduced were the following: for the ready-to-drink juice and puree track, changing the paper stock used from nonglossy to glossy water-proof paper; for the high-end cheese and by-products track, inclusion of short trivia about cheese and their product, as well as pictures, and changing the logo; and for microbial rennet track, including pictures in the packaging. These changes resulted in more appealing, readable, durable, and informative labels.

The cheese and microbial rennet track student-technopreneurs employed markup pricing. The pricing was based on the costs of producing and distributing the product and the desired markup, which is 20% for cheese

and 25% for microbial rennet. The following formula was used to calculate the selling price using markup pricing:

$$\text{Selling price} = \frac{\text{Unit cost}}{1 - \text{Desired markup}}$$

The selling price of a liter of liquid microbial rennet was PhP 435.00 (unit cost = PhP 327.35) while each 200-g tub of cream cheese and ricotta was PhP 80.00 (unit cost = PhP 63.24). Note that computed price was rounded off to the nearest whole digit divisible by 5.

$$\text{Microbial rennet:} \quad \text{Selling price} = \frac{327.35}{1 - 0.25} = 436.47 \approx \text{PhP } 435.00$$

$$\text{Cream cheese / ricotta:} \quad \text{Selling price} = \frac{63.24}{1 - 0.20} = 79.05 \approx \text{PhP } 80.00$$

On the other hand, the fruit juice and puree student-technopreneurs adopted a competitive pricing strategy as there are already quite a number of fruit juice products in the market. Generally, the selling price was still based on the costs of production and distribution but a lower markup of 18% was employed so the selling price would be lower than existing juice drinks in the markets. The average selling price for a 350-mL ready-to-drink juice was PhP 15.00 (unit cost = PhP 12.30), which is cheaper by PhP 6.00 compared to other brands.

$$\text{Ready-to-drink fruit juice:} \quad \text{Selling price} = \frac{12.30}{1 - 0.18} = \text{PhP } 15.00$$

One student-technopreneur who produced calamansi puree adopted the penetration pricing strategy as the product was quite new in the market, pricing a 5-mg pack of puree at PhP 2.00.

As microbial rennet was a new technology, the rennet technopreneurs considered direct selling as the most appropriate marketing mode for this product. Since their target market were cheese producers, they needed to market their products in another town, such as Sta. Cruz, Laguna, where most of the white cheese producers are located. In selling, they needed to talk personally to cheese processors and give away product samples in order to convince them to try the new product. Most of the fruit juice technopreneurs also chose to employ direct selling, but they focused their distribution within UPLB, with their friends, relatives, classmates, and roommates as their primary

customers. However, they reported some inconvenience in delivering and transporting their products as these were heavy and bulky. They countered this issue by renting public transportation (e.g., tricycles) and seeking the help of friends who had vehicles. Transportation cost, on the average, comprised almost 50% of selling expenses. The cheese technopreneurs, on the other hand, regarded selling through intermediaries like operators of sales bars in university buildings and contacts within Los Baños and in other towns as the more efficient way of selling their products. There was one student-technopreneur who sold his products through the DTRI dairy bar and a privately owned fresh milk sales outlet. The outlets sold his products for PhP 140 per 200-g tube, and they received PhP 20 per tub as their consignment fee.

Furthermore, there were some who were able to extend their market reach outside of Los Baños. For example, one of the cream cheese student-technopreneurs produced cream cheese for a group of students from Ateneo de Manila University (AdMU) who were targeting high-end markets in Metro Manila.

The student-technopreneurs also demonstrated creativity in promoting and marketing their products. Amidst the presence of competitors who had already established a strong foothold in the market, the student-technopreneurs managed to win loyal customers within and outside Los Baños. Nine of them (34.6%) took advantage of social networking sites such as Facebook, Twitter, Blogger, Tumbler, and Yahoo and free advertisement Web sites like Silit.com and Aayosdito.ph to promote their products. Start-up entrepreneurs save marketing expenses by undertaking nontraditional marketing activities. They tend to resort to spreading the word about their products using free Web sites and social network sites. Some of them relied on the more traditional promotional forms such as posters (26.9%), word of mouth (23.1%), and product samples (19.4%). The four student-technopreneurs under the microbial rennet technology, upon the suggestion of the PCIEERD project team, conducted product usage demonstrations (15.4%) for white cheese producers, and one (3.8%) made instructive pamphlets on how to use the product.

Start-up Assessment

The start-ups of the student-technopreneurs were assessed according to the following parameters: financial performance, the entrepreneurial competencies developed by the students, and the number of businesses registered after the project.

Financial performance. One of the major indicators of a business's success is its ability to earn revenues to sustain its operations. The financial performance of the student-technopreneurs can be assessed using the amount of positive cash flows generated, which can then be plowed back to the business to finance succeeding productions. It is important to note that the computation of profits

is based on the cash sales and expenses of the student-technopreneurs but does not include opportunity costs of labor, equipment, technology, and technical support. For this reason, the return on investment (ROI) was not computed since it will not reflect a fair estimate of the rate of return.

Among the three TLPs, the high-end cheese and by-products TLP recorded the highest mean return at PhP 3,738.23, which was expected, given the higher profit margin that the student-technopreneurs set for their products. With the exception of one student, everyone under this TLP posted positive net profits. However, only two out of the seven students generated earnings greater than the mean (Table 1). It is apparent that production efficiency is a key factor in the profitability of the TLP. The yield of cheese varies depending on the quality of the raw materials used and the efficiency of the process. The outcome of the cheese start-ups clearly illustrates that ventures that promise high returns are also accompanied by high risk.

The fruit juice and puree start-ups, on the other hand, posted moderate returns. Profit margin for them was relatively small at PhP 857.75 because of intense competition with commercially available fruit juice products. Two out of the fifteen students posted negative returns, but only about half of the student-technopreneurs in this technology track recorded a return higher than the mean (Table 1).

Finally, the microbial rennet TLP posted a negative mean return of PhP 1,466.59. Only one out of the four students earned positive returns (Table 1). Despite conducting demonstrations, producing informative pamphlets, and giving away samples, student-technopreneurs under this TLP were unable to convince most cheese producers to use microbial rennet instead of imported rennet or ordinary vinegar as coagulant.

In terms of financial management, the student-technopreneurs found it challenging to maintain two separate accounts, their personal and business accounts. They encountered difficulty in managing their cash flow and collecting their receivables. The students addressed these problems by practicing self-control in terms of spending and religiously recording and accounting expenses and serving customers who agreed to pay upon delivery.

Entrepreneurial competencies developed. Throughout the course of their technopreneurial experience, the students claimed that they developed important entrepreneurial competencies, skills, and values. The most frequently cited were the following: time and resource management (29.6%), acquisition of technological know-how (25.9%), communication and interpersonal skills (22.2%), persistence (22.2%), and demand for quality (22.2%).

The BS Agribusiness Management majors considered gaining a working knowledge of the technologies they were working on the most important skill they acquired from the specialized courses during the conduct of the AFNR and PCIEERD-DOST projects and summer trainings. The processes they

learned during the course of the program were not taught in the technical subjects they were required to take in their curriculum, and this made them realize that they were given a rare opportunity. Due to the number of technical problems encountered, those under the cheese technology track recognized that mastering production processes is a prerequisite to running successful technology-based enterprises. The other competencies and skills cited were the following: resourcefulness (18.5%), dedication/passion (18.5%), commitment to work contract (18.5%), innovativeness/creativity (18.5%), self-confidence (14.8%), opportunity-seeking (14.8%), patience (14.8%), appreciation for a the importance of a business plan (11.1%), professionalism (7.4%), and hard work (7.0%).

It is worthy to note that most of these competencies coincide with the ten personal entrepreneurial competencies (PECs) cited by David McClelland that characterize successful entrepreneurs: opportunity-seeking, persistence, commitment to work contract, risk-taking, demand for efficiency and quality, goal setting, information seeking, systematic planning and monitoring, persuasion and networking, and self-confidence (Diaz, 1993).

The most financially successful student-technopreneur reported that during the course of running his start-up, he took pains to behave and dress like a businessman by observing seasoned entrepreneurs that he was in contact with. He also developed a client tracking system database wherein important information about his clients were stored; and to solve the problem of high logistics cost in picking up his raw milk supply, he connected his supplier, who was looking for an outlet for their ready-to-drink milk products in Los Baños, to his current milk retail outlet. This case illustrates how the PECs were translated to action for the success of the business venture.

Businesses registered. Among the twenty-six student-technopreneurs, only seven (26.9%) registered their businesses: four (15.4%) from the fruit juice and puree technology track and three (11.5%) from the high-end cheese technology track. Most of the others, however, have plans to register their businesses in the future. They perceive that their current production scale is too small to require business registration. None of the microbial rennet student-technopreneurs registered their businesses because of limited production and resistance of local cheese makers in adopting the new product.

The student-technopreneurs who registered their businesses did so in order to (1) market their products outside of their town; (2) be able to issue receipts in future dealings, especially with institutional buyers like supermarkets, restaurants, and hotels; and (3) enable them to apply to the Food and Drug Administration (FDA) for approval to supply supermarkets.

One student claimed that his father's connections in the different government offices enabled the former to expedite the registration process.

Summary, Conclusion, and Recommendations

The AFNR project provided trainings and initial logistics support geared towards promoting an entrepreneurial mindset in UPLB, and these produced twenty-six student-technopreneurs who transformed their business plans into actual businesses in high-end cheese and by-products production, fruit juice and puree production, and microbial rennet production. Through a complementary project, PCIEERD-DOST provided the supplementary funds for the commercialization of these identified technologies. With the assistance of business management and technical mentors, these student-technopreneurs were able to address the various problems they encountered along the way and finally produced and marketed their products with varying success. Using three parameters, namely, financial performance, entrepreneurial competencies developed, and the number of business registered after the project, the study also assessed the success of the TLPs.

From a financial standpoint, the high-end cheese and by-products TLP was the most successful, with most of the student-technopreneurs (85.7%) posting positive net profits and the TLP having the highest mean return at PhP 3,738.23; followed by the fruit juice and puree TLP, with most of its student-technopreneurs (80%) posting positive net profits and moderate mean return at PhP 857.75; and the microbial rennet being the least successful, with only one (25%) of the student-technopreneurs posting positive net margins and negative mean return at PhP 1,466.59. However, among those in the cheese technology track, only 28% gained more than the mean profit unlike those in the fruit juice track (53.3%), which indicates that ventures promising high returns are also accompanied by high risk. The success of the participants under both tracks suggest that it is much easier to penetrate the market when selling end-products (i.e., fruit juice, puree, cream cheese, and ricotta) than inputs to production (i.e., microbial rennet). Perhaps more demonstrations are necessary to educate the cheese producers about the benefits of using the new product and convince them to shift to using a new technology.

In terms of entrepreneurial competencies developed, the students were able to acquire personal entrepreneurial competencies that are vital to the success of a start-up venture. But for a technopreneur, as the participants of the project noted, the most important among these competencies is the acquisition of technological know-how, considering the central role that innovation plays in technology-based enterprises. In terms of the number of businesses registered after the project, there were only a few student-technopreneurs who did so, and predictably, these came from the two more successful TLPs. However, the fact that some of these graduates of AFNR-related courses are seriously considering being technopreneurs as a career path is a clear indication of success. The next step perhaps is to look at the scalability of these start-up ventures to encourage more business registrations.

The factors which contributed to the success of the viable technopreneurial ventures under the two technopreneurship-related projects were the following: (1) the use of cost-effective nontraditional marketing venues such as free advertisement Web sites (e.g., Sulit.com and Ayosdito.ph) and social network sites (e.g., Facebook, Twitter, Blogger, Tumbler, and Yahoo) in addition to more traditional marketing methods (e.g., posters, word of mouth, product samples); (2) networking with marketing intermediaries like operators of food stalls in university buildings and contacts in other towns; and (3) family support in the venture through assistance in financing, marketing, and labor.

Overall, the UPLB AFNR and the PCIEERD-DOST projects jointly contributed to achieve the goal of promoting a technopreneurial mindset among the constituents of UPLB, particularly students, and encouraging them to venture into technology-based start-up businesses by giving them the necessary tools, both technical and related to business management, and capital. Indeed, there is really merit in having projects that complement and reinforce each other to achieve success.

Lastly, this paper offers the following future directions for research and recommendations on how to improve the conduct and monitoring of similar projects in the future, drawing from the experiences of the participants and the insights gained by the project management team:

1. Conduct similar or follow-up projects focusing on student start-ups that utilize other mature technologies of UPLB. In the case of fruit juice and puree production, for example, product development research should focus on other indigenous fruits and raw materials. These researches are necessary prior to commercialization through technopreneurship-related projects.
2. A number of changes must be instituted to the implementation of any technopreneurial project: First, the duration of start-up implementation must be lengthened because technology-based start-ups need more than five months to take off. Second, the financial administration of the project by assisting government agencies and UPLB can be improved to avoid delays, which can adversely affect the start-up. Lastly, students should be given the opportunity to apply for cash advances and liquidating these to provide them hands-on experience in financial management, which is crucial to the success of a business.
3. Institutionalize a technopreneurship course or program at the undergraduate level in UPLB. This integrative and multidisciplinary course can be spearheaded by DAM and also involve the technical units in the university.

4. Establish a technopreneurial laboratory for exclusive use by student-technopreneurs and a UPLB-administered sales outlet for products derived from university technologies. These exclusive facilities will avoid problems in production scheduling as experienced by fruit juice and puree student-technopreneurs conducting their production in the processing plant of the Food Science Cluster (FSC).
5. Conduct detailed case studies of the technology-based enterprises whose operations are successfully sustained even after the termination of the two projects. By documenting the processes undergone by the enterprises while incubated in the TBI, the challenges and lessons learned from these start-ups will help future ventures avoid pitfalls and adopt best practices.
6. Undertake an in-depth research on the enabling environment necessary to accelerate technology commercialization and technopreneurship in academic and R&D institutions.
7. Carry out more studies on the potential markets and appropriate marketing strategies for biotechnology products like microbial-based rennet. This can help future student-technopreneurs as most of those under this TLP registered negative returns.
8. Conduct a comparative research of the performance of a start-up managed by a team versus that of an individual.
9. Conduct a study to track the sustainability and business performance of the start-ups of student-technopreneurs after a number of years.

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