



DEVELOPMENT OF AN ORGANIC AGRICULTURAL LEARNING CENTRE HIGHLIGHTING SUSTAINABILITY

**An Interactive Qualifying Project
Submitted to the Faculty of
CHULALONGKORN UNIVERSITY**

**In Partial Fulfillment of the
Requirements for the Degree of the
Bachelor of Applied Science in
Chemistry**

Sponsor:
Wat Pathumwanaram School
Under the Royal Patronage of H.R.H. Princess
Maha Chakri Sirindhorn

Advisors:
Dr. Christopher Smith
Dr. Rick Attrill
Assoc. Prof. Nattaya Ngamrojanavanich



**Kroerit Maneejark
Kunaporn Kittisopidadit
Lalita Radtanajiravong
Thanida Dangprasert
Varinporn Lerdporncharoen
Woojin Park**

ABSTRACT

Wat Pathumwanaram School expects to fulfill organic agriculture learning through hands-on experience. This project aims to suggest the best idea to efficiently utilise the received adjacent land at Wat Pathumwanaram School into an organic agricultural learning centre for current and future student generations. The project will enable the school to integrate organic agricultural techniques into their existing agricultural courses through the use of a developed educational hands-on activity and a model of the organic agricultural learning centre. They will serve as active and visual teaching methods to provide students with an understanding of organic agriculture. These objectives were achieved by doing archival research, interviews with botanical experts and organic agricultural course teachers, and site assessment.

ACKNOWLEDGEMENTS

Our team would like to thank the following individuals and organizations for their assistance and support throughout our project:

- Wat Pathumwanaram School, Under the Royal Patronage of H.R.H. Princess Maha Chakri Sirindhorn, for supporting our project, providing space for us to work, and supplying the necessary resources to complete the project
- Mr. Sompob Intharachan, the Wat Pathumwanaram School's director, for his continuous support and great interest in the progress of the project
- Mr. Wirat Kanpan, the Wat Pathumwanaram School's co-director, for his continuous support and suggestions
- Dr. Christopher Smith, Dr. Rick Attrill, and Assoc. Prof. Nattaya Ngamrojanavanich, our project advisors, for their continual support and guidance
- Assist. Prof. M.L. Siripatr Jayanta, the course coordinator, for working behind the scenes to make this project happen
- Miss Lalita Prasard, organic agricultural course teacher at the Wat Pathumwanaram School, for the tour of the school and insight educational system of the school
- Assist. Prof. Dr. Kanogwan Seraypheap and Assist. Prof. Dr. Yongyuj Chunyarak, botanist experts at the Department of Botany, Chulalongkorn University, for their kindness in providing us with the knowledge of organic agriculture and for their suggestions
- Lak Si District Organization, Bangkok, for allowing us the opportunity to do field observation in their organic garden
- Miss Pensri Tosa-ard, Lak Si district officer, for the tour of the 'Organic Rooftop Garden' at Lak Si District

EXECUTIVE SUMMARY

Thailand, a country known for its agricultural expertise, is continuously growing and changing to advance its agricultural development. Organic agriculture provides a substantial way of life promoting the philosophy of sustainable living. An ideal organic environment will enable the garden to replenish resources while simultaneously making use of them. Compost, animal wastes, decaying plants, and even grass clippings are used instead of external chemical fertilisers.

Over the past 30 years, His Majesty the King has emphasised in his teachings and royal speeches the philosophy of sustainable living, which is supported by the concept of organic agriculture. Sustainable living and being self-sufficient are the act of living in moderation, responsible consumption, and resilience to external undesired circumstances, which is of significant relevance to widespread communities.

To reinforce the agricultural industry in Thailand, organic agriculture knowledge is becoming more common and widespread in more rural areas of Thailand. With the intention of educating students about the King's Principle, the Ministry of Education in Thailand supports the education of self-sufficient living, promoting natural literacy in areas rapidly urbanised by technological advances. Due to the concept's usability and success in the agriculture industry, many schools are trying to adapt this knowledge into their curriculum to increase recognition of this concept. Wat Pathumwanaram School is one of the schools that would like to incorporate the concept of organic agriculture into their academic curriculum.

Wat Pathumwanaram School currently offers two agricultural facilities—a mushroom shed and a hydroponics plantation—both of which do not satisfy aspects of the school's curriculum concerning incorporating the sustainable principle into school courses and providing hands-on activity to students. The goal of our project was to suggest the best idea to efficiently utilise the received adjacent land at Wat Pathumwanaram School into an organic agricultural learning centre for current and future student generations.

By means of a carefully laid out design of the organic agricultural learning centre itself, we hope that our project will aid the school to visualise and convey their future plans for the received plot of land to provide an organic agricultural learning centre that will not only enhance the student's natural literacy, but also eventually deliver a positive impact for their community.

METHODOLOGY

The initial task of the project was to ensure that the organic agricultural learning centre could fit into the Wat Pathumwanaram School curriculum. To achieve this, we conducted interviews with the director and organic agricultural course teacher.

We then did site assessment to ensure that the organic agriculture is suitable for the plot of land. We studied important factors influencing plant growth, which are soil, sunlight pattern, water source and natural fertilisers, within the plot of land. After further field research and interviewing with experts, we finalised suitable organic agricultural techniques to adapt for the plot of land, which included nursery plant beds and intercropping.

We then made the list of organic plants through archival research based on factors mentioned previously. After interviewing botanical experts and organic agricultural course teachers at Wat Pathumwanaram School about their experiences on each type of plant, we narrowed the list down to finalise the most appropriate plants for the plot of land.

To present the conceptualised virtual model design, we integrated all findings and then initially designed the final model using the Sims computer software and finally, established a design of organic agricultural learning centre. To ensure that this model will involve students when the learning centre is built in reality in the future, we conducted archival research on effective hands-on activity that would help complement the learning centre.

FINDINGS

OBJECTIVE 1: DETERMINE HOW THE LEARNING CENTRE CAN BE APPLIED AND USED WITHIN THE SCHOOL'S EXISTING CURRICULUM

Finding 1: The school's curriculum lacks an organic agriculture course for students to experience growing plants from the soil

Through archival research and interviews with Miss Lalita Prasard, an agricultural course teacher at Wat Pathumwanaram School, we examined the details of the school's curriculum. We found out that the school offers two agricultural plantations as electives and basic agricultural courses. None of these options provide organic agricultural knowledge to students; neither do they equip students with hands-on experience on strategies to grow plants using soil-based techniques.

Finding 2: Secondary grade students have basic knowledge of agriculture

From the interview with Miss Lalita Prasard and information from using archival research for obtaining the curriculum, we found that secondary grade students have basic knowledge of agriculture from lectures provided in their classes.

Finding 3: Vegetables are the best choice of organic plants to grow for the benefit of the students and the school

A variety of possible plants can be grown in this plot of land and our findings supported that vegetables are the most beneficial choice for both the school and the student population.

OBJECTIVE 2: IDENTIFY SUITABLE ORGANIC AGRICULTURAL METHODS AND SYSTEMS AS A BASIS FOR THE LEARNING CENTRE

Finding 4: The four main factors that influence plant growth are sufficient in the allotted plot of land

After considering these four main factors (soil, natural fertilisers, sunlight, and water source) and in conjunction with advice from botanist experts, we found that both soil and sunlight are suitable and sufficient for growing organic plants in the allotted plot of land. However, an additional water source will be suggested in the learning centre model to eliminate insufficient water area coverage problems.

Finding 5: Nursery plant beds, mature beds, and intercropping are suitable organic agricultural methods and systems

Strategies of organic plant growth must be accounted for when designing the model for long-term usage. Nursery plant beds and mature beds will aid healthy growth of plants and intercropping will alleviate the damage caused by pests. These agricultural methods and systems do not require chemical substances to ensure the growth of plants.

OBJECTIVE 3: DEVELOP A PROTOTYPE DESIGN FOR THE LEARNING CENTRE AND EDUCATIONAL MATERIALS TO INTRODUCE ORGANIC AGRICULTURE TO STUDENTS

Finding 6: The organic plants to be grown on the plot of land will consist of a variety of vegetables and herbs

After conducting interviews with botanical experts, we narrowed down the types of plant to finalise the list of organic plants that can be grown in this plot of land. Bird's eye chili, Holy basil, Sweet basil, Kale, Pea aubergine, Morning glory, Chinese cabbage, Banana tree, Ginger, Galangale, Lemon basil, Lemongrass, Goat pepper, Fah Talai Jone and Aloe vera are the final herbs and edible plants.

Outcome 1: The ‘Organic Plants Hunter Game’ was developed successfully as a suitable activity to complement the organic agricultural learning centre

Through interviews, our team incorporated the teachers’ ideas and opinions into our Organic Plants Hunter Game and came up with a finalised idea for the educational activity. To conclude, students and agricultural course teachers evaluated the activity and it achieved the objectives that our team set for the game, which was to introduce organic agriculture to students.

Outcome 2: The prototype design in virtual model form, using all information obtained as a basis for the design

We used the information obtained from all our research and findings to assist in the design. The landscape, its environmental factors, and other details were used as a basis for the design. Environmental factors, such as sunlight patterns, were significantly considered for suitable placement of plants. Plants that require more water were located closer to the water source. The prototype model was designed in 3D using the Sims computer software.

Outcome 3: A physical model of the organic agricultural learning centre

We researched for proper materials and techniques on doing landscape garden design. Included in our research topics were the suitable scale of the model and the way to create small items, such as artificial soil and plants. This model was required to fulfill the project's goal because it was used to represent the whole picture and details in the design. Finally, this was the best way to explain how it is the best design and sustainable model of learning centre.

CONCLUSION

Through our archival research, experts’ interviews, and site assessment, we were able to achieve four main objectives. These include incorporating the existing the school’s curriculum to the organic agricultural learning centre, identifying suitable organic agricultural systems and methods for the plot of land, creating the learning centre design in physical three-dimensional form, and organizing a piloted and evaluated educational activity for Wat Pathumwanaram School.

RECOMMENDATIONS

5.2.1 Organic Agricultural Learning Centre Maintenance

The learning centre should include opportunities for student involvement in its maintenance. Since plants were chosen for ease of maintenance and durability, students would not have a problem to take care of these plants. Sustainable maintenance can be done successfully by using available resources within the school efficiently. Since the school already has several mushroom sheds, we recommend that unused mushrooms from the mushroom shed could be used as organic matter to provide proper nutrients for the soil. Without even having to purchase new materials, the school would be able to circulate agricultural materials within their own ecosystem to create an effective sustainable organic agricultural learning centre.

5.2.2 Using the Organic Agricultural Learning Centre's Model as an Educational Aid for Students

We recommend that the school use the organic agricultural model as an educational material for students. Using the model as an educational material, students will be able to see the overall picture of the garden, as well as details of an organic agricultural system in three-dimensional form.

5.2.3 Teaching the Differences Between Organic Agricultural Techniques and other Agricultural Techniques through Hands-On Experience

We recommend that teachers allow their students to compare hydroponic learning centre and mushroom houses that already exist within the school with organic agriculture, using the same types of plants. We can conclude that students would more easily understand the advantages and disadvantages of different agricultural techniques because they have opportunities to compare and contrast an additional agricultural technique.

5.2.4 Incorporation of the School's Organic Agricultural Learning Centre into Nearby Communities

We suggest that the school can provide extracurricular courses for parents and nearby communities on weekends to spread methods of growing organic plants and how to maintain plant growth using the sustainability concept. Our findings have shown that organic agriculture can be successfully developed and maintained in a small area within an urban community.

รายงานฉบับย่อ

ประเทศไทยเป็นประเทศที่มีความเชี่ยวชาญด้านการเกษตรกรรมและได้มีการพัฒนาอย่างต่อเนื่อง การปลูกพืชแบบเกษตรอินทรีย์เป็นอีกทางเลือกหนึ่งของการเกษตรแบบยั่งยืนและ ยังเป็นการใช้ทรัพยากร ทุนเวียนซึ่งจะไม่ใช้สารเคมีใดๆในการเพาะปลูกโดยจะใช้ปุ๋ยหมักมูล สัตว์ ชากพืช หรือใช้เศษหญ้า ทดแทนการใช้ปุ๋ยเคมี พระบาทสมเด็จพระเจ้าอยู่หัวฯ ทรงได้ตระหนักถึงความสำคัญของการใช้ชีวิตอย่าง พอเพียง ท่านทรงบัญญัติปรัชญาเกี่ยวกับความเป็นอยู่อย่างยั่งยืนขึ้นซึ่งสนับสนุนแนวความคิดการทำเกษตร อินทรีย์

ความรู้เกี่ยวกับการเกษตรแบบอินทรีย์เริ่มเป็นที่รู้จัก และแพร่หลายในชนบท ซึ่งกระทรวง ศึกษาธิการ ได้แพร่กระจายความรู้ตามแนวทางพระราชดำริและด้วยเทคโนโลยีที่ทันสมัยจึงทำให้ ปรัชญา ของพระองค์แพร่หลายออกไปยังชุมชนอย่างรวดเร็ว โรงเรียนจำนวนมากเริ่มนำไปประยุกต์ ใช้ ให้เข้ากับ หลักสูตรการเรียนการสอนของตนเอง ซึ่งทางโรงเรียน วัดปทุมวนารามในพระราชูปถัมภ์ฯ ก็เป็นหนึ่งใน โรงเรียนที่มีการน้อมนำแนวความคิดเกษตร แบบอินทรีย์มาประยุกต์ ใช้ให้เข้า กับหลักสูตรการเรียนการสอน ของทางโรงเรียน ปัจจุบัน โรงเรียนวัดปทุมวนารามในพระราชูปถัมภ์ฯ ได้มีการจัดทำศูนย์การเรียนรู้ทาง การเกษตรสองศูนย์การเรียนรู้ คือ โรงเพาะเห็ดและ การปลูกพืช แบบไฮโดรโปนิกส์ ทางโรงเรียนได้จัด กิจกรรม ภายในศูนย์การเรียนรู้ ทั้งสองนี้แต่ยังไม่สอดคล้อง โดยตรงกับการสอน ปรัชญาความเป็นอยู่อย่าง ยั่งยืน ให้แก่นักเรียนนิสิตได้เล็งเห็น ปัญหา และ ได้ การเสนอแนวคิดในการสร้างพื้นที่ ที่ได้รับมอบหมาย ให้เป็น ศูนย์การเรียนรู้ทาง เกษตรอินทรีย์ ให้มี ประสิทธิภาพ และยั่งยืน สำหรับนักเรียนในโรงเรียนในรุ่น ปัจจุบันและใน รุ่นต่อไป

ทางนิสิตหวังเป็นอย่างยิ่งว่าโครงการนี้จะสามารถช่วยให้ทางโรงเรียนมองเห็นภาพรวมและถ่ายทอด แผนการอนาคตสำหรับศูนย์การเรียนรู้ได้อย่างยั่งยืนได้ ศูนย์การเรียนรู้นี้มีเพียงแต่เป็น ประโยชน์แก่นักเรียน เพียงอย่างเดียวแต่ยังสามารถถ่ายทอดความรู้ไปยังชุมชนรอบๆบริเวณโรงเรียนได้อีกด้วย

ขั้นตอนการดำเนินงาน

จุดประสงค์หลักของโครงการนี้คือการเสนอแนวคิดการสร้างศูนย์การเรียนรู้ทางการเกษตรอินทรีย์ที่สามารถประยุกต์เข้ากับหลักสูตรการเรียนการสอนของทางโรงเรียนได้ ซึ่งวิธีดำเนินงาน นั้น นิสิตได้ ทำการสัมภาษณ์ผู้อำนวยการโรงเรียนและคุณครูผู้สอนวิชาเกษตรกรรม นอกจากนี้ได้ทำ การสำรวจ พื้นที่ที่จะพัฒนาเพื่อสำรวจความเหมาะสมของพื้นที่ว่าสามารถปลูกพืชแบบเกษตรอินทรีย์และเหมาะสมกับ ปัจจัยหลักที่ใช้การในการปลูกพืชหรือไม่ โดยปัจจัยหลักในการปลูกพืช คือ ประเภทของดินดิน, ความชื้น ของแสงแดด ,แหล่งน้ำ และการใช้ปุ๋ยหมัก หลังจากที่ได้ทำการสำรวจ พื้นที่และปรึกษาผู้เชี่ยวชาญด้าน เกษตรอินทรีย์ ทำให้ทราบว่า การปลูกพืชในพื้นที่นั้น ควรจะต้องจัด พื้นที่ไว้สำหรับแปลงอนุบาล และ แปลงผักซึ่งควรปลูกพืชหลายๆชนิดภายในหนึ่งแปลงเพื่อความ แข็งแรงให้แก่ดิน

คณะนิสิตได้ทำการค้นคว้าหาข้อมูลเพิ่มเติมเกี่ยวกับชนิดของพืชที่เหมาะสมกับสภาพแวดล้อม ของ พื้นที่พัฒนา หลังจากนั้นก็ทำการสัมภาษณ์ผู้เชี่ยวชาญด้านเกษตรอินทรีย์เพื่อขอความรู้ เกี่ยวกับพืชชนิด ต่างๆ และ คัดเลือกว่ามีชนิดใดที่เหมาะสมแก่การปลูกเพื่อการศึกษาแก่นักเรียน กระบวนการเสนอความคิด ผ่านการสร้างแบบจำลองของศูนย์การเรียนรู้นั้นได้ใช้ โปรแกรม คอมพิวเตอร์ ‘The Sims’ ในการสร้างแบบ จำลองสามมิติเพื่อให้เห็นภาพอย่างสมจริง และ ลงมือ สร้างแบบ จำลองศูนย์การเรียนรู้ทางเกษตรอินทรีย์ เพื่อที่จะให้ทาง โรงเรียนมั่นใจ ว่านักเรียนใน โรงเรียนจะ สามารถใช้ศูนย์การเรียนรู้ได้อย่าง แท้จริง นอกจากนี้ คณะนิสิตได้ทำการ ค้นคว้าหา ข้อมูลเกี่ยวกับกิจกรรม สำหรับเด็กนักเรียนให้มีส่วนร่วม กับศูนย์การเรียนรู้อีกด้วย

ขั้นตอนการค้นหาวัตถุประสงค์วัตถุประสงค์ที่ 1:

ศูนย์การเรียนรู้ทางการเกษตรอินทรีย์สามารถเชื่อมโยงเข้ากับหลักสูตรการเรียนการสอนของ ทางโรงเรียน

การค้นหที่1: หลักสูตรการเรียนการสอนของทางโรงเรียนยังขาดการให้ความรู้แก่นักเรียนด้านการ เกษตรอินทรีย์

หลังจากที่นิสิตได้ทำการสัมภาษณ์คุณครูผู้สอนวิชาเกษตรกรรมของทางโรงเรียนวัดปทุมวนารามฯ ทราบว่า ทางโรงเรียนได้มีการจัดสอนในวิชาเลือกเกี่ยวกับการเกษตรสองอย่างคือ การเพาะเชื้อเห็ด และการปลูกพืช แบบไฮโดรโปนิกส์ ซึ่งทั้งสองอย่างนี้ไม่ได้ให้ความรู้เกี่ยวกับการทำเกษตรอินทรีย์ แก่นักเรียน

การค้นหาคำที่2: นักเรียนชั้นมัธยมศึกษาตอนต้นมีความรู้เบื้องต้นด้านเกษตรกรรม

หลังจากที่ได้ทำการสัมภาษณ์ คุณครูลลิตาซึ่งเป็นผู้สอนวิชาเกษตรกรรม คุณครูชี้แจงว่า หลักสูตรการเรียนการสอนได้ให้ความรู้เบื้องต้นเกี่ยวกับเกษตรกรรมแก่นักเรียนชั้นมัธยมศึกษาตอนต้น ซึ่งนักเรียนระดับนี้มีความรู้พื้นฐาน ที่จะต่อยอดความรู้ทางด้านเกษตรอินทรีย์ได้

การค้นหาคำที่3: ชนิดของพืชที่เหมาะสมแก่การปลูกที่สุดเพื่อที่จะให้ประโยชน์ ทั้งแก่นักเรียน และทางโรงเรียน คือผักสวนครัว

ภายในพื้นที่พัฒนาจากสามารถปลูกพืชได้หลายชนิด และหลังจากที่ได้ทำการหาข้อมูลแล้วจึงทำให้รู้ว่าชนิด ของพืชที่เหมาะสมที่สุดคือผักสวนครัว

วัตถุประสงค์ที่2: ขั้นตอนและวิธีการทำการเกษตรอินทรีย์ที่เหมาะสมกับศูนย์การเรียนรู้

การค้นหาคำที่4: ปัจจัยหลักที่สามารถมีผลกระทบต่อการปลูกพืช ได้แก่ ดิน น้ำ แสงแดด และปุ๋ย

หลังจากที่ได้รับคำแนะนำจากผู้เชี่ยวชาญด้านเกษตรอินทรีย์ทำให้ทราบว่าชนิดของดินในแปลงและแสงแดดที่ลงในแปลงนั้นเหมาะสมและเพียงพอต่อการปลูกพืชแบบเกษตรอินทรีย์แล้ว อย่างไรก็ตาม คณะนิสิตแนะนำให้ทางโรงเรียนให้เพิ่มแหล่งน้ำภายในแปลงเพิ่มอีกหนึ่งที่ เพื่อป้องกันการ ขาดแคลนน้ำ

การค้นหาคำที่5: วิธีการปลูกพืชแบบเกษตรอินทรีย์ที่เหมาะสมสำหรับพื้นที่พัฒนา

ศูนย์การเรียนรู้ด้านเกษตรอินทรีย์นั้นสร้างขึ้นตามแนวความคิดการใช้ชีวิตความเป็นอยู่ตามแนวทางเศรษฐกิจพอเพียง ซึ่งการปลูกพืชโดยไม่ใช้สารเคมีนั้นเป็นวิธีหนึ่ง ในการดำเนินตามหลักการใช้ทรัพยากรธรรมชาติในการปลูกพืชให้เกิดประโยชน์สูงสุด

วัตถุประสงค์ที่3: ออกแบบจำลองศูนย์การเรียนรู้ทางการเกษตรอินทรีย์อย่างพอเพียง และออกแบบสื่อการเรียนการสอนเพื่อให้ความรู้เบื้องต้นเกี่ยวกับการทำการเกษตรอินทรีย์ให้แก่ นักเรียน

การค้นหาคำที่6: ชนิดผักที่เหมาะสมแก่การปลูกในพื้นที่พัฒนา

หลังจากที่ได้เข้าไปขอคำปรึกษาจากอาจารย์ผู้เชี่ยวชาญด้านเกษตรอินทรีย์กับทางคณะพฤกษศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย พืชที่เหมาะสมแก่การปลูกในแปลงของทางโรงเรียนมากที่สุด ได้แก่ พริกชี้หนู, ใบกะเพรา, ใบโหระพา, คื่นช่าย, มะเขือเปราะ, ผักบุ้ง, กวางตุ้ง, ต้นกล้วย, ขิง, ข่า, แมงลัก, ตะไคร้, พริกชี้ฟ้า, ฟักทอง และวุ้นเส้น ซึ่งทั้ง 15 ชนิดนี้เป็นพืชผักสวนครัวและพืชสมุนไพร

การค้นหาคำที่ 7: เกมส “ตามล่าหาพืชอินทรีย์” เป็นกิจกรรมที่เหมาะสมแก่เด็กนักเรียน เพื่อที่จะให้มีส่วนร่วมกับการเรียนรู้

นิสิตได้ทำการสัมภาษณ์คุณครูผู้สอนด้านเกษตรกรรมของโรงเรียนเพื่อที่จะขอคำแนะนำและความคิดเห็นเกี่ยวกับการจัดกิจกรรมให้แก่เด็กนักเรียนซึ่งก็ได้มีความเห็นว่าเกมส “ตามล่าหาพืชอินทรีย์” นั้นเหมาะที่จะเป็นกิจกรรมเพื่อเพิ่มความรู้ให้แก่เด็กนักเรียน หลังจากการจัดกิจกรรม กับเด็กนักเรียน แล้วทางนิสิตได้ให้คุณครูของทางโรงเรียนประเมินกิจกรรม กิจกรรมนี้บรรลุเป้าหมายการเรียนรู้ ทางด้านการให้ความรู้เบื้องต้นเกี่ยวกับเกษตรอินทรีย์ให้แก่เด็กนักเรียน

การค้นหาคำที่ 8: การใช้โปรแกรมคอมพิวเตอร์ในการออกแบบจำลองสามมิติ โดยใช้ปัจจัยสำคัญต่างๆ เป็นองค์ประกอบในการออกแบบ

นิสิตได้ใช้ข้อมูลสำคัญทั้งหมดที่มีเพื่อใช้เป็นหลักสำคัญในการออกแบบ ทั้งจากการค้นคว้าเพิ่มเติมจากอินเทอร์เน็ต ปัจจัยหลักสำคัญของสภาพแวดล้อม เช่น การได้รับแสงแดดและ น้ำที่เพียงพอ ซึ่งถ้าพืชชนิดใดต้องการน้ำมากก็จะปลูกไว้ตรงที่ใกล้แหล่งกระจายน้ำ การออกแบบ จำลองนี้ใช้โปรแกรมคอมพิวเตอร์ในการจัดทำ เพื่อให้ง่ายและสะดวกในการเปลี่ยนแปลงและ ปรับปรุง

การค้นหาคำที่ 9: การออกแบบจำลองศูนย์การเรียนรู้เสมือนจริง

นิสิตได้ทำการค้นคว้าข้อมูลเกี่ยวกับอุปกรณ์รวมถึงวิธีการทำแบบจำลองเสมือนจริง เช่น ขนาดที่เหมาะสมในการทำแบบจำลอง และวิธีการที่จะสร้างวัตถุจำลองขนาดเล็ก เช่น ดินและพืชผัก การสร้างแบบจำลองนี้ได้บรรลุวัตถุประสงค์ของโครงการเพราะนอกจาก จะทำให้เห็นภาพรวมของแปลง และรายละเอียดภายในแบบจำลองแล้ว ยังเป็นวิธีที่ดีที่สุด ในการอธิบายศูนย์การเรียนรู้ ทางเกษตรอินทรีย์ ได้อย่างชัดเจนอีกด้วย

บทสรุป

โครงการนี้ นิสิตได้ทำการค้นคว้าหาข้อมูล ขอคำปรึกษาจากผู้เชี่ยวชาญ และออกสำรวจพื้นที่ ซึ่งท้ายที่สุดได้บรรลุเป้าหมายของโครงการ โดยเสนอแนวความคิดศูนย์การเรียนรู้ ให้เข้ากับ หลักสูตร การเรียนการสอนได้ และเสนอวิธีการทำเกษตรกรรมแบบอินทรีย์ ที่ถูกต้องและ เหมาะสมกับสภาพพื้นที่ ของทางโรงเรียน ทางนิสิตได้นำเสนอแผนจำลองเสมือนจริงของ ศูนย์การเรียนรู้ทางเกษตรอินทรีย์ขึ้น และ มอบแบบจำลองนี้ให้กับทางโรงเรียนวัดปทุมวนาราม ในพระราชูปถัมภ์ฯ เพื่อใช้เป็นสื่อการเรียนการสอน ให้นักเรียนต่อไป

ข้อเสนอแนะเพิ่มเติม

การบำรุงรักษาศูนย์การเรียนรู้เกษตรอินทรีย์

โรงเรียนควรจัดการเรียนการสอนนักเรียนเกี่ยวกับการดูแลพืชอินทรีย์ เพื่อให้เด็กได้เข้าร่วมการ ดูแลพืชในศูนย์การเรียนรู้เกษตรอินทรีย์ เนื่องจากชนิดพืชที่ได้เลือกมานั้นง่ายต่อการดูแลรักษา และเป็น พืชที่สามารถทนต่อสภาพอากาศได้ดี ซึ่งทางนิสิตมีความเห็น ว่านักเรียนสามารถเรียนรู้ และดูแลพืชเหล่านี้ ได้ การใช้ทรัพยากรหมุนเวียนภายในโรงเรียน เป็นอีกหนึ่งวิธีเพื่อสร้างความยั่งยืนให้แก่ศูนย์การเรียนรู้ คณะนิสิตเสนอแนวความคิดนำ เศษอินทรีย์วัตถุที่เหลือจากการเพาะเชื้อเห็ด สามารถใช้เป็นปุ๋ยอินทรีย์ได้ โรงเรียนสามารถใช้แบบจำลองศูนย์การเรียนรู้เกษตรอินทรีย์เป็นสื่อการเรียนการสอนได้

โรงเรียนสามารถใช้แบบจำลองเสมือนจริงที่คณะนิสิตได้สร้างขึ้นมาใช้เป็นสื่อการเรียนการสอน ซึ่งภายในแบบจำลองนั้น นอกจากจะทำให้เด็กนักเรียนสามารถมองเห็นภาพโดยรวม ของพื้นที่จริงได้อย่าง ชัดเจนแล้ว ภายในแบบจำลองยังอธิบายรายละเอียด การปลูกพืชอินทรีย์ โดยรวมได้อีกด้วย คณะครูควรสอนเด็กนักเรียนให้รู้ข้อแตกต่างระหว่างการเกษตรแบบอินทรีย์และการเกษตรในรูปแบบอื่นๆที่มี ในโรงเรียนโดยให้นักเรียนได้ลงมือปฏิบัติจริง

ทางนิสิตมีความเห็นว่าโรงเรียนควรสอนให้เด็กนักเรียนได้เรียนรู้ข้อแตกต่างระหว่างการปลูกพืช แบบ ไฮโดรโปนิคส์กับการปลูกพืชแบบอินทรีย์อย่างไร การจัดกิจกรรม ให้เด็กได้มีส่วนร่วมลงมือ ปฏิบัติได้ความรู้ข้อดีข้อเสียของการเกษตรแต่ละแบบให้ นักเรียนเรียนรู้ได้ง่ายขึ้น

โรงเรียนสามารถถ่ายทอดความรู้เกี่ยวกับเกษตรอินทรีย์ไปยังชุมชนใกล้เคียงได้

สุดท้ายนี้ ทางโรงเรียนสามารถถ่ายทอดความรู้การปลูกพืชแบบอินทรีย์ให้กับชุมชนใกล้เคียงได้ โดยสามารถใช้เวลาช่วงวันหยุดให้ความรู้เกี่ยวกับวิธีการและการดูแลรักษาพืชอินทรีย์ให้แก่ชุมชนใกล้เคียง โดยยึดหลักการเกษตรพอเพียง หลังจากทางนิสิตได้ทำการค้นคว้าหาข้อมูลครบ ทุกขั้นตอน ทำให้ทราบว่าสามารถปลูกพืชแบบเกษตรอินทรีย์ได้ไม่ยากและง่ายต่อการดูแลรักษา แม้จะอยู่ในย่านใจกลางเมืองที่มีเนื้อที่จำกัด

AUTHORSHIP

Lalita Radtanajiravong wrote the initial drafts of the Methodology and the Results and Analysis sections. She then continued to develop the Abstract, Methodology, Results and Analysis, and revised the Conclusions and Recommendations chapters. Lalita also organised the References and helped format the report. She also contributed resourceful ideas for the project's direction and progress.

Thanida Dangprasert served as the main editor for all drafts, editing all sections before compiling them into one report. She wrote the initial drafts for the Introduction chapter and Conclusions and Recommendations chapter. In addition, she also created and designed the team's presentations and edited videos for the team. As an active part of the discussion, Thanida also contributed creative ideas for the project.

Kunaporn Kittisopidadit was the main coordinator for numerous parts in the project. Her contributions in the report include sections in the Literature Review, Methodology, Results and Analysis, mainly regarding topics related to our sponsor, Wat Pathumwanaram School. She mainly wrote sections that require Thai language skills, including sections of the Thai educational school system and the Appendix chapters.

Varinporn Lerdporncharoen was responsible for the organization of the initial and final plants list. She was also the main assistant for the design and creation of the model. She also contributed to sections in the Literature Review, Methodology, Results and Analysis, mainly regarding topics related to plants and their properties.

Kroerit Maneejark was our primary creator and designer for the model. His contributions were also valuable in the list of organic plants, organization of the educational activity materials, and gathered information for natural conditions in Bangkok. Kroerit also contributed to the Literature Review, Methodology, Results and Analysis, and all parts of the report related to the model's design.

Woojin Park was the primary researcher on organic agriculture. Moreover, he contributed to the report during the revision of the Literature Review chapter. According to his research, he wrote organic agriculture, benefits of organic agriculture, and essential factors in organic agriculture. Woojin also contributed constructive analytical ideas for the project.

TABLE OF CONTENTS

ABSTRACT	<i>i</i>
ACKNOWLEDGEMENTS	<i>ii</i>
EXECUTIVE SUMMARY (ENGLISH)	<i>iii</i>
EXECUTIVE SUMMARY (THAI)	<i>viii</i>
AUTHORSHIP	<i>xiv</i>
TABLE OF CONTENTS	<i>xv</i>
LIST OF FIGURES	<i>xviii</i>
LIST OF TABLES	<i>xix</i>
CHAPTER 1: INTRODUCTION	1
CHAPTER 2: LITERATURE REVIEW	4
2.1 SUSTAINABLE AGRICULTURE	4
2.1.1 The Sustainability Principle – King Bhumibol’s Philosophy	4
2.2 EDUCATION ON SUSTAINABILITY IN THAILAND	5
2.2.1 Wat Pathumwanaram School History	7
2.3 ORGANIC AGRICULTURE	9
2.3.1 Background of Organic Agriculture in Thailand	9
2.3.2 Growing Procedures and Key Factors of Growing Organic Plants	11
2.3.3 Benefits of Urban Organic Agriculture	12
2.4 ASPECTS IN DESIGNING AN ORGANIC GARDEN	13
2.4.1 Natural Conditions in Bangkok	13
2.5 ESSENTIAL FACTORS IN ORGANIC AGRICULTURE	15
CHAPTER 3: METHODOLOGY	17
3.1 OBJECTIVE 1: DETERMINE HOW THE LEARNING CENTRE CAN BE APPLIED AND USED WITHIN THE SCHOOL’S EXISTING CURRICULUM	18
3.1.1 Interviewed the director of Wat Pathumwanaram School	18
3.1.2 Interviewed an agricultural course teacher at Wat Pathumwanaram School	18
3.2 OBJECTIVE 2: IDENTIFY ORGANIC AGRICULTURAL METHODS AND SYSTEMS AS A BASIS FOR THE LEARNING CENTRE	19
3.2.1 Archival research about organic agriculture strategies	19
3.2.2 Interviewed experts in organic agriculture and gardening	19
3.2.3 Site assessment	19
3.2.4 Field research at ‘Organic Rooftop Garden – Lak Si’	20
3.3 OBJECTIVE 3: ESTABLISH A PROTOTYPE DESIGN FOR THE LEARNING CENTRE AND EDUCATIONAL MATERIALS TO INTRODUCE ORGANIC AGRICULTURE TO STUDENTS	20

3.3.1 Interviewed agricultural course teachers for suitable plants	20
3.3.2 Developed educational materials for students' activity	21
3.3.3 Designed a three-dimensional model of the organic agricultural learning centre using a computer program	21
3.3.4 Designed a solid three-dimensional model of the organic agricultural learning centre	22
CHAPTER 4: RESULTS AND ANALYSIS	23
4.1 OBJECTIVE 1: DETERMINE HOW THE LEARNING CENTRE CAN BE APPLIED AND USED WITHIN THE SCHOOL'S CURRICULUM	23
4.1.1 Finding 1: The school's curriculum lacks an organic agriculture course for students to experience growing plants from the soil	23
4.1.2 Finding 2: Secondary grade students have basic knowledge of agriculture	25
4.1.3 Finding 3: Vegetables are the best choice of organic plants to grow for the benefit of the students and the school	25
4.2 OBJECTIVE 2: IDENTIFY ORGANIC AGRICULTURAL METHODS AND SYSTEM AS A BASIS FOR THE LEARNING CENTRE	26
4.2.1 Finding 4: The four main factors that influence plant growth are sufficient in the allotted plot of land	26
4.2.2 Finding 5: Nursery plant beds, mature beds, and intercropping are suitable organic agricultural methods and systems	31
4.3 OBJECTIVE 3: ESTABLISH A PROTOTYPE DESIGN FOR THE LEARNING CENTRE AND EDUCATIONAL MATERIALS TO INTRODUCE ORGANIC AGRICULTURE TO STUDENTS	32
4.3.1 Finding 6: The organic plants to be grown on the plot of land will consist of a variety of vegetables and herbs	32
4.3.2 Outcome 1: The 'Organic Plants Hunter Game' was developed successfully as a suitable activity to complement the organic agricultural learning centre	35
4.3.3 Outcome 2: The prototype was designed in virtual model form, using all information obtained as a basis for the design	37
4.3.4 Outcome 3: The physical model of the organic agricultural learning centre	38
CHAPTER 5: CONCLUSION AND RECOMMENDATIONS	40
5.1 SUMMARY OF FINDINGS	40
5.1.1 The Organic Agricultural Learning Centre is Applicable for the Existing School's Curriculum	40
5.1.2 Organic Agriculture System and Methods	41
5.1.3 The Prototype Design of the Organic Agricultural Learning Centre	41

5.1.4 Educational Activity for Providing Basic Organic Agricultural Knowledge to Secondary Students	42
5.2 RECOMMENDATIONS	42
5.2.1 Organic Agricultural Learning Centre Maintenance	42
5.2.2 Using the Organic Agricultural Learning Centre's Model as an Educational Aid for Students	43
5.2.3 Teaching the Differences Between Organic Agricultural Techniques and other Agricultural Techniques through Hands-On Experience	43
5.2.4 Incorporation of the School's Organic Agricultural Learning Centre into Nearby Communities	44
REFERENCES	45
APPENDIX A: SEMI-STRUCTURED INTERVIEWS AND RESPONSES WITH THE DIRECTOR OF WAT PATHUMWANARAM SCHOOL	48
APPENDIX B: SEMI-STRUCTURED INTERVIEWS AND RESPONSES WITH TEACHERS	49
APPENDIX C: SEMI-STRUCTURED INTERVIEWS AND RESPONSES WITH EXPERTS	53
APPENDIX D: ENGLISH AND THAI EDUCATIONAL SYSTEMS	59
APPENDIX E: MAP OF WAT PATHUMWANARAM SCHOOL	60
APPENDIX F: LIST OF FINAL APPROPRIATE ORGANIC PLANTS WITH PROPERTIES	61
APPENDIX G: ORGANIC PLANTS HUNTER GAME EVALUATION FORM	76
APPENDIX H: ORGANIC PLANTS HUNTER GAME	77
APPENDIX I: THREE-DIMENSIONAL PROTOTYPE DESIGN IN VIRTUAL DESIGN DEVELOPMENTS	78

LIST OF FIGURES

Figure 1: Wat Pathumwanaram School layout	7
Figure 2: Rainy days in Bangkok, Thailand	14
Figure 3: Sun hours in Bangkok, Thailand	15
Figure 4: Soil at the plot of land	26
Figure 5: Finalised virtual model designed in the Sims computer software	38
Figure 6: Finalised physical model of organic agricultural learning centre	39

LIST OF TABLES

Table 1: Sufficiency economy learning outcomes corresponding to student grade level	6
Table 2: Bangkok seasons and temperature	14
Table 3: The successes and limitations of the hydroponic plant learning centre and mushroom houses	24
Table 4: Sunlight patterns at the plot of land	28
Table 5: The final list of appropriate organic plants	34

CHAPTER 1: INTRODUCTION

A country rich with culture and tradition, Thailand is also known for being one of the world's top agricultural exporters. Just as the country is adapting the world's technological advances, agricultural development also has to be continuously improved. For more than three years organic agriculture has become a major theme for the current agricultural trends in Thailand.¹ After the idea was enlisted as the nation's policy by the government, several groups of Thai farmers had to take the initiative and incorporate organic agriculture to promote safe and healthy food.

Organic agriculture maintains the general principles of using natural plant fertilization and pest management systems for production of organic food. This includes not using any synthetic or chemically derived products, such as pesticides or artificial fertilisers, to assist growing plants.² Not only are pesticides or chemical fertilisers harmful to the environment, they are also harmful to end customers who ingest pesticides from contaminated vegetables into their body. Growing edible and useful plants organically will strongly improve the quality of life within the community, as well as the quality of the land and soil. Feeding composted plants to foster healthy soil and growing conditions is one of the methods of organic agriculture.

In an ideal organic environment, the garden will replenish resources as it makes use of them. "Feed the soil and the soil will feed the plants," is one of organic agriculture's basic concepts.³ Decaying plants, animal wastes, compost, grass clippings, and dried leaves are some examples of organic matter.⁴ Because organic agriculture focuses on using what is available instead of investing in new resources, organic agriculture has become a way to efficiently use available resources sustainably. Thus, organic agriculture is in parallel with the concept for sustainable agriculture. After the King's Sustainability Principle⁵ initiative became widespread throughout Thailand, the ideal of teaching students how to live more self-sufficiently became more common.

As mentioned in the previous paragraph, organic agriculture promotes sustainable living. Farmers are able to gain more profit from their crops because they can make use of what is already there and save expenses.⁶ Spreading organic agriculture knowledge can potentially strengthen the agricultural industry in Thailand. Due to the concept's usability and

success in the agriculture industry, many schools are trying to adapt this knowledge into their curriculum and provide students with courses that will increase recognition of this concept. Among other schools located in Thailand, Wat Pathumwanaram School is one of the schools that would like to incorporate the concept of organic agriculture into their academic curriculum.

Ironically located in the bustling city of Bangkok in between some of Bangkok's most luxurious shopping centres, Wat Pathumwanaram School used to be an educational centre with inadequate educational materials for students with parents that receive a low income. Without proper education, these children may lack equal opportunities for a better life. Her Royal Highness Princess Maha Chakri Sirindhorn has been well aware of disadvantaged Thai citizens excluded from the mainstream of education in urban communities. Although the school went by unnoticed to the public, Wat Pathumwanaram School was fortunate to receive attention from H.R.H Princess Maha Chakri Sirindhorn in 2007 and since then has gained continual support to further improve the school's facilities and curriculum to provide students with ample knowledge for a brighter career path.⁷ At present, the school now stands as a modernised educational institute for students from kindergarten through to the ninth grade.

Despite the ongoing development for Bangkok to be a completely developed and industrialised city, it is still important that a lot of the traditional household agriculture knowledge be retained and passed on to future generations. To preserve traditional Thai literacy, school officials at Wat Pathumwanaram School have invested in several agricultural gardens on school grounds and developed agricultural courses that are integrated into the existing curriculum. Rigorously highlighted as part of the school's curriculum is also the self-sufficient and sustainable living concept, which the school tries to demonstrate through their agricultural facilities. Two of the current agricultural facilities offered to students at Wat Pathumwanaram School consist of mushroom sheds and a hydroponics plantation – both of which do not satisfy all aspects of the school's curriculum. The mushroom sheds were not able to involve a lot of student participation due to delicate and complex maintenance procedures. Hydroponics, the agricultural technique that took plant cultivation to a new level, simply costs too much to setup and maintain.

Wat Pathumwanaram School realises that their agricultural program has the potential for further improvement through the implementation of an organic agricultural learning

centre. To provide better opportunities for students' hands on learning experience, Wat Pathumwanaram School has noticed each previous project's drawbacks and brainstormed for an idea that will benefit its students. The goal of our project was to suggest the best idea to efficiently utilise the received adjacent land at Wat Pathumwanaram School into an organic agricultural learning centre for current and future student generations. To achieve this goal, these objectives were met:

1. Determine how the learning centre can be applied and used within the school's existing curriculum
2. Identify organic agricultural methods and systems as a basis for the learning centre
3. Establish a prototype design for the learning centre and educational materials to introduce organic agriculture to students

Through multiple interviews conducted with botanical experts and teachers, archival research, educational site visits, and analysis of case studies, we accumulated and identified organic agricultural knowledge as the basis for the learning centre to accomplish our goal. We also analysed the information gathered to make educated suggestions and recommendations for future reference.

We believe that incorporating organic agricultural education into Wat Pathumwanaram School's curriculum to promote sustainability and developing a model as a medium to suggest the best idea to efficiently utilise the allotted plot of land will be beneficial to the school's students. Through a carefully laid out design of the organic agricultural learning centre itself, we hope that our project will aid the school to visualise and convey their future plans for the received plot of land to provide an organic agricultural learning centre that will not only enhance the student's agricultural knowledge but also eventually furnish a positive impact for their community.

CHAPTER 2: LITERATURE REVIEW

2.1. SUSTAINABLE AGRICULTURE

In sustainable agriculture, reaping the most benefits out of available assets will help solve problems in the Thai agriculture industry and also lead Thai people to adapt the principle of sustainability into their lives, thereby enhancing the quality of life for Thai farmers and for the society as a whole.

2.1.1 The Sustainability Principle – King Bhumibol’s Philosophy

Throughout his reign, His Majesty the King Bhumibol Adulyadej has emphasised his principles in royal addresses and speeches on various occasions. Living effectively, simply and frugally forms the basis of the sustainability principle, tailored to fit the needs of local Thai citizens and to solve problems from their root causes. These ideals were to build a firm foundation for the prosperity and happiness of people in all parts of the country. His Majesty the King’s speech to Thai people in 1997 described the philosophy of being self-sufficient and living sustainably, as outlined in the following quote:

“In fact, I have often said, the important thing is for us to have a self-supporting economy. A self-supporting economy means to have enough to survive.”⁸

H.M. King Bhumibol Adulyadej has since educated the general population, urging them to live in prudence and to understand the concept of sustainability. Sustainability rests on the principle that the people must meet the needs of the present without compromising the ability of future generations to meet their own needs.¹ The sustainability concept can be discussed using three main principles. The first principle encourages people to produce and consume resources only as much as needed. The second principle for sustainability is to provide basic needs for everyday life, which can be used for a long period of time. Lastly, to protect against any undesired circumstances in the future, such as unforeseen problems, the risk planner needs to have vision and must be ready to foresee all possibilities, good or bad. With a vision for the economy, sustainability can be used to avoid unwanted circumstances

through risk management.⁹ Self-sufficiency is the concept of living on goods produced locally, keeping people satisfied with what they have and causing less trouble to other people.

Sufficiency economy is a happiness development approach for the nation to progress in economic growth, which emphasises the middle path as an overriding principle for appropriate conduct by people at all levels and social status. The middle path is commonly practiced by not living too extravagantly or too thriftily. It encourages people to live in a way where they consume only what they really need, choose products carefully, and consider their impact on others and on the planet. The sufficiency economy enhances the nation's ability to modernise without defying globalization. It provides a means to respond to negative outcomes caused by rapid economic transitions. This philosophy is a guide to making decisions that will generate outcomes that are beneficial to the development of the country.¹⁰

2.2 EDUCATION ON SUSTAINABILITY IN THAILAND¹¹

Thai educational systems often emphasise the importance of sustainability, as referred from the Ministry of Education.¹² The goal is to adapt the self-sufficiency principle to Thai government schools, which will be integrated into their school's curriculum. This concept was introduced in Thailand¹³ and its adaptation into the school's curriculum was divided into two phases. The first phase began in the years 2006-2007, which was intended for personnel or leaders within communities to understand the principles of a self-sufficient economy and sustainable living. Then, the concept expanded continuously to educational institutions, thereby incorporating these principles into school curriculums throughout the Kingdom of Thailand. The second phase, beyond the year 2007, strategises the expansion of these principles to invite other private schools to participate in this campaign to accomplish their target. Learning outcomes related to the sufficiency economy from the curricula for each grade level are shown in Table 1.

Table 1: Sufficiency economy learning outcomes corresponding to student grade level¹²

Grade Level	Expected Learning Outcome
Grade 1 (๑.1)	Be able to have self-responsibility and know how to save money
Grade 2 (๑.2)	Be able to have family-responsibility and have a good discipline to use money wisely
Grade 3 (๑.3)	Be responsible for their community and be able to analyse their income and expense
Grade 4 (๑.4)	Be able to apply their income and expense to use in their daily lives
Grade 5 (๑.5)	Be able to use self-sufficient economy in their families
Grade 6 (๑.6)	Be able to understand and utilise Thai traditions and cultures into their lifestyles. Be able to analyse the self-sufficient economy theory
Grade 7 (๒.1)	Be able to adapt sufficient economy to use for their families, their society and for themselves
Grade 8 (๒.2)	Be able to observe the money problem in their community
Grade 9 (๒.3)	Be able to participate in solving their community's problem
Grade 10 (๒.4)	Be able to apply state enterprise corporation to their community
Grade 11 (๒.5)	Be able to utilise sufficient economy at the national level
Grade 12 (๒.6)	Be able to employ a continuous sufficient economy

2.2.1 Wat Pathumwanaram School History



Figure 1: Wat Pathumwanaram School layout⁷

The sponsor of this project, Wat Pathumwanaram School, under the Royal Patronage of H.R.H Princess Maha Chakri Sirindhorn¹⁴ (Figure 1) is located in the heart of Bangkok's financial and commercial district, surrounded by skyscrapers, shopping complexes, and 5-star hotels. Built on the grounds of Pathumwanaram Temple, its nearby regions consist of low-income communities. Most of school's students also come from these low-income housing communities.

Since Wat Pathumwanaram School is classified as one of the government schools, the government supplied an annual budget to help fund the school's expenses. However, in the past, the amount was insufficient due to increasing education fees. As a consequence, by May 2007, there was a lack of budget for supporting student lunches. A sign could be seen placed in front of the school, announcing that students received education as first priority and food came as second priority. Fortunately, Her Royal Highness Princess Maha Chakri Sirindhorn noticed a community that has been missed for years. She stepped closer and more intimately listened to the lives of people in this low-income community. H.R.H. Princess Maha Chakri

Sirindhorn formed a charity, which helped fund communities and Wat Pathumwanaram School. ‘The H.R.H. Princess Maha Chakri Sirindhorn Charity’ focuses on improving living conditions, educating Thai youth in rural areas, and promoting higher education.¹⁵

On June 18, 2007, an opening ceremony was held for a newly reformed version of Wat Pathumwanaram School, under the patronage of H.R.H Princess Maha Chakri Sirindhorn. The school was revamped, and now has computer technology and two new libraries. Many classrooms are now equipped with computers. English, Chinese, and Japanese language studies are provided in the curriculum. There are now approximately 40 teachers and over 700 students in the school. The school now provides free uniforms and school lunches to all students.

Today, the school looks to expand their curriculum to include hands on activities outside classrooms and developing a self-sufficient and sustainable learning environment through their agricultural learning centre. For example, the school constructed an herbal garden with reused available rubber tiles and plastic bottles to demonstrate waste conservation.

The school is currently providing excellent educational opportunities for students within the community. The project has been set out to design an educationally applicable organic garden in order to fill the school’s gap in agricultural hands-on experiences for students. The previous project at Wat Pathumwanaram School and initiatives embracing the concept of sustainability are discussed below as a case study. These activities are provided to students as part of their curriculum — a general education course for interested intermediate students.

Case Study: Perennial Garden

In 2013, students from Chulalongkorn University started an Interactive Social and Science Project¹⁶ involving creating a green area in Wat Pathumwanaram School. The objectives of this project were to design a school garden with the concept of having a green area with an appropriate ecological system in mind and providing plant knowledge to students. This project was successful in providing a shadier and greener area in the school by planting perennial trees along the school fence. Moreover, this garden provides nametags of

all plants in the garden to make it easier for students to learn about perennial trees. Students learn each perennial plant's figure and their usage from a garden manual in the school's library.

2.3 ORGANIC AGRICULTURE

Organic agriculture is an agricultural system that relies on ecosystem management without using any other external agricultural inputs. According to the USDA National Organic Standards Board (NOSB), organic agriculture is defined as “an ecological production management system that promotes and enhances biodiversity, biological cycles, and soil biological activity. It is based on minimal use of off-farm inputs and on management practices that restore, maintain, or enhance ecological harmony. The primary goal of organic agriculture is to optimise the health and productivity of interdependent communities of soil life, plants, animals and people.”¹⁶

These days, farmers are trying to adopt organic agriculture with an ecologically based, systematic approach that includes long-term planning and major investment in equipment and supplies. Although it is still a small industry, the amount of organic agricultural land usage is growing in many continents, such as Asia, Europe, North America and Oceania.¹⁷

2.3.1 Background of Organic Agriculture in Thailand

Primarily due to the country's favourable climate conditions and well-developed agricultural processing facilities, Thailand is an agriculture-based country. A large portion of the population in Thailand earns their income from agriculture. Organic agriculture is not a new concept in Thailand; local Thai farmers have practiced traditional agriculture for hundreds of years. These practices have been developed and enriched by the farmer's knowledge of local agro-ecology and environmentally sustainable way of farming. Since agriculture was the way to survive for local farmers in Thailand, they naturally adapted sustainability into their agriculture technique. Through the imposition of modern agriculture, local native knowledge of sustainable farming has been merged and changed due to people's

needs. The survival of these farms is the source of the renewal of modern organic agriculture in Thailand today.¹⁸

In the early 1980s, the re-emergence of organic farming can be traced back to the collapse of modern agriculture. Up until this time, conventional farming systems' production was run towards cash-crop production with heavy dependence on agrochemicals. As a result, farmers were exposed to market instability and health hazards. When agriculture products declined in demand, production costs still rose steadily, causing a significant number of farmers to go bankrupt. Millions of small-scale farmers were driven to be indebted and forced them out of their own farmlands. At the same time, the impacts of the excessive use of agrochemicals began to spread out. Increasingly frequent incidents of health hazards to farmers and consumers were reported.¹⁸ From 1971-1981, the number of patients suffering from chemical poisoning dramatically increased by 96% (from 74 cases in 1971 to 2,170 cases in 1981).¹⁸ These circumstances caused many farmers and local NGOs to begin searching for alternatives to conventional agriculture in order to break away from the circle of debt and health risks. In 1984, the Alternative Agriculture Network was established as a national network of NGOs and farmer organizations to support alternative agriculture in Thailand.¹⁹ It provides a discussion forum for experience sharing and policy advocacy for sustainable agriculture, including organic farming. It has a decentralised structure for coordination with regional groupings in the northern, north eastern, central and southern regions of Thailand. In recent years, organic agriculture has gained more and more popularity. In 1995, the Organic Agriculture Certification Thailand (ACT) was founded, and is one of the important organizations that provides professional organic certification services for all farm production as well as processing and handling operations. In the early 1990s, the first official recognition of sustainable agriculture occurred on the regulatory side when the Seventh National Economic and Social Development Plan (1992-1996) expressed an interest in sustainable agriculture. However, no exact target or projects were set up until the Eighth Plan (1997-2001). Until the end of the 1990s, there were no government bodies or research institutions that were officially engaged in organic agriculture.¹⁹

2.3.2 Growing Procedures and Key Factors of Growing Organic Plants

The basic concept of growing organic vegetables or organic types of plants requires a step-by-step process because organic vegetables are sensitive. Also, the quality of organic vegetables is process dependent. Without the use of herbicides or any kind of chemically related treatment, these processes have to be done carefully with special techniques to gain the highest productivity and the best quality of organic plants. These suggested steps should be followed consequently in order to grow them the right way. Firstly, the land should be located in an appropriate area near a water source, where there is plenty of sunlight. Birds and animals should not be able to get into this plot of land. The next step is to prepare an organic garden seedbed and plant-bed by deciding the size and shape of the garden bed, digging out the area using a shovel or a spade, then mixing the compost with soil. Compost is an important matter, which can be made from recycled garden and kitchen wastes by adding compostable items to the compost heap. Eventually, this compost heap will degrade and compost over time.²⁰ The third step involves sowing seed on to the seedbed. At this particular step, suitable plants that can grow well in the region and soil type should be identified. Finally, baby sprouts are carefully placed onto the plant-bed. Organic plants should be labeled in order to identify the available types of plants in the garden.²⁰

In general, we can check the quality of organic plants by certain factors, as the greenness of the leaves, colouration, internode length, stem diameter, and leaf thickness have to specially be considered to obtain the highest productivity and quality of organic plants. The limitations of plant growth are mainly influenced by environmental factors: temperature, radiant energy (sunlight) and soil properties.²¹ Measurements of heat intensity or temperature is needed since some plants can grow well in tropical areas, while others may grow well in different conditions. The temperature directly affects photosynthesis, respiration, transpiration and absorption of water and nutrients. The Department of Scientific and Industrial Research at Palmerston University studies how plants behave under climate stress.²² Their research has proven that the temperature influences photosynthetic rates of both sorghum and ryegrass grown. Research by Shinji Tazawa in 1998, involving the effects of various radiant sources on plant growth at Saitama, Japan, has proven that quality, intensity, and the duration of light or radiant energy are important for factors to consider when placing different types of plants.²³ For example, tomatoes, melons, and peppers require high levels of sunlight for proper growth while lettuce, spinach, and broccoli will grow very

well even with limited sunlight.²⁴ Lastly, to grow organic plants, a significant factor to consider is soil property. Organic soil, without chemicals, is needed for farming organic plants. The two main soil properties that influence organic growth are temperature and moisture.²⁵ Temperature affects growth in two ways. First, plants tend to grow faster and produce more total mass as temperatures increase. Second, as the temperature increases, microbial activity, including the activity of decomposing microorganisms, also increases, which stimulates growth rate. Good soil moisture also makes total plant production increase because it improves nutrient uptake. Moreover, the level and type of nutrients in the soil is also an important factor that influences plant growth. Mineral nutrients from soil dissolve through water and are absorbed via the roots. However, fertilisers are needed to add more nutrients to soil, since nutrients in soil may run out over time.

2.3.3 Benefits of Urban Organic Agriculture

Urban agriculture is the practice of distributing, cultivating, and processing food in or around a town, village, or city. Urban organic agriculture offers many advantages compared to rural organic agriculture. One of the main advantages is that the sustainability of cities can be enhanced through urban agriculture. For example, it has potential for long-term maintenance of wellbeing, which has ecological, and economic, political and cultural dimensions.²⁶ Producing food in urban areas means cities will be able to better sustain themselves, while also reducing the need for waste disposal transportation. When urban wastes are used as inputs for urban food production (such as food wastes), urban agriculture can help cities to become more resource efficient and reduce the amount of waste that has to be disposed of.²⁶ Throughout Africa, urban wastewater flows are often used in urban agriculture.²⁷

Economic benefits from urban organic agriculture are also significant. Urban agriculture can provide income, generate employment and make use of otherwise unused resources, especially wastes and waste water.²⁸ Urban organic agriculture can provide better livability to citizens by changing their surroundings. It can contribute through three ways: by improving the local climate (quality of air and temperature), by ‘greening’ the city environment, and by providing opportunities for recreation and interaction with other citizens.²⁹ While one could argue that a greener city environment is not necessarily a better living environment, research indicates that it is evaluated as such and that natural

environments help urban occupants in dealing with stress. Urban agriculture can have a positive impact on community structure by bringing people together with a common purpose.²⁹

2.4 ASPECTS IN DESIGNING AN ORGANIC GARDEN

In order to design an organic garden, weather conditions in Bangkok, as well as prospective organic plants, should be considered. Other organic gardens in an urban environment will also be discussed in this section as case studies.

2.4.1 Natural Conditions in Bangkok

The natural condition is an important factor for growing organic plants in each area. The information of annual weather is required because this will influence types of organic plants grown, and maintenance methods used during the year. This information will focus only in the Bangkok area due to the location of Wat Pathuwanaram School.

Topography

The topography of Bangkok is relatively flat, with most areas being situated on a plain. The average sea level is about 1.50 to 2 meters, with the slope of the ground level gently sloping downhill from the Northern Gulf of Thailand to the South.³² The lower continent is above sea level, not exceeding 1.50 meters located in the geographical area. It is a fertile area suitable for rice cultivation and agriculture.³³

Season and temperature

Bangkok has a tropical climate and it is under the influence of two types of monsoon coming from the Northeast and Southeast. Table 1 shows three different seasons in Bangkok and their temperatures.

Table 1: Bangkok seasons and temperature

Seasons	Months	Temperature (°C)		
		Maximum	Minimum	Average
Summer	February-April	40	23	30
Rainy	May-October	39	23	28
Winter	November-January	36	17	27

Rainy days

Intensity of precipitation is another effect that can cause damage to some types of organic plants. Figure 2³⁴ shows rainy days during 2013 by month. There is little rain in January, February and December. In September, most days of the month are rainy, hence plants that need less water have to be well maintained in order to avoid premature death.

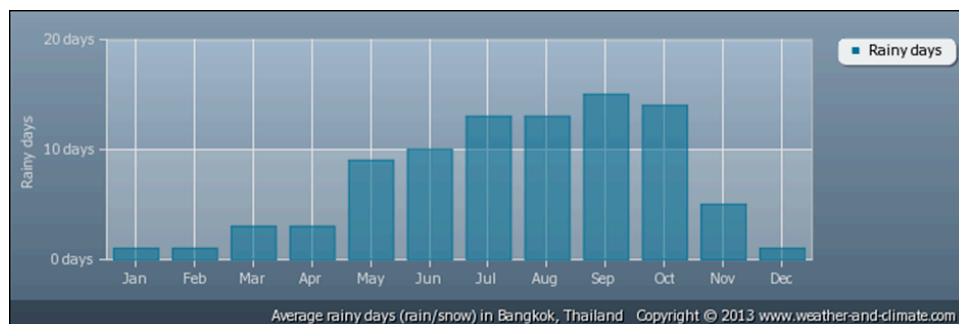
**Figure 2:** Rainy days in Bangkok, Thailand³⁴*Sun Hours*

Figure 3³⁵ displays the monthly sunlight hours in 2013. The graph illustrates that there are longer daylight hours in January to April, and again in November to December. However, the number of sun hours in May to October is not as high. This information is necessary to categorise what kind of plants are grown in certain months. Most vegetables and flowers require large amounts of sunlight. For vegetables grown in a garden, proper amounts of direct sunlight each day are required to produce crops.

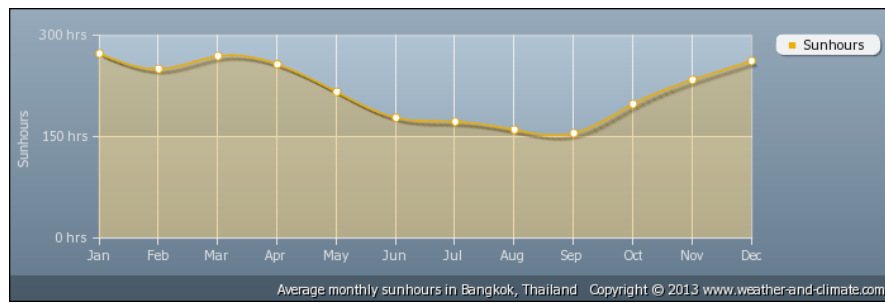


Figure 3: Sun hours in Bangkok, Thailand³⁵

2.5 ESSENTIAL FACTORS IN ORGANIC AGRICULTURE

Organic gardening simply means not using any synthetic fertilisers or pesticides, but this does not mean that organically grown plants would be able to survive on their own. There are several ways to bolster plant nutritional quality and protect them from pests. Organic gardening is not only about growing plants without the use of chemically infused products, but also about trying to foster a natural ecosystem.

Organic Soil

Organic soils are formed by the accumulation of partially decomposed organic matter. Organic matter is composed of organic compounds that come from the remains of once-living organisms, such as plants and animals and their waste products in the environment. Moreover, easy-to-find items ranging from kitchen wastes and shredded leaves can be used as organic matter.³⁶ Organic matter does not remain unchanged once it has been added to soil. Less than 5 to 6 percent of organic matter is required in order to control soil microorganisms to consume nitrogen and other nutrients for soil fertility. Several advantages of using organic matter include the following:

1. Organic matter can be the major source of both sulfur and phosphorus for plants when organic matter is present in appreciable amounts
2. Organic matter is the main source of the nitrogen in unfertilised soils
3. Once top of the soil has been mulched by organic matter, it can reduce erosion, rapid moisture loss, and keeps the soil cooler in hot weather³⁸
4. Soil retention is one of the key factors of soil functioning as an ecosystem

The effect of changes in soil water retention depend on the proportions of the textural

components and the amount of organic carbon present in the soil, and this organic carbon can be provided from organic matter³⁹

Ecological Pesticides

The main difference between typical pesticides and ecological pesticides is the source, whether it has been derived from organic or chemical compounds. The main criterion for organic pesticides is that they are naturally derived, but some naturally derived substances have been controversial. However, many ecological pesticides can still be made from inexpensive materials, and noxious (but non-toxic) materials, such as cayenne, stinging nettles, horsetail, and garlic, which are diluted in water and blend, which is then sprayed on the plants.⁴⁰

CHAPTER 3: METHODOLOGY

Wat Pathumwanaram School received a 12x7 metre plot of land adjacent to the school. To turn this opportunity into something beneficial for the students, the school director has decided to convert this land into an organic agricultural learning centre. The problem statement of our project was that Wat Pathumwanaram School had no utilization plan for the acquired plot of land and the school has inadequate hands-on activities to emphasise sustainability. Our goal was to suggest the best idea to efficiently utilise the received adjacent land at Wat Pathumwanaram School into an organic agricultural learning centre for current and future student generations.

To achieve this goal, these objectives had to be met:

1. Determine how the learning centre can be applied and used within the school's existing curriculum
2. Identify organic agricultural methods and systems as a basis for the learning centre
3. Establish a prototype design for the learning centre and educational materials to introduce organic agriculture to students

These three objectives were achieved by the following methodologies in chronological order. To achieve objective number 1, we interviewed the director and an agricultural course teacher of Wat Pathumwanaram School. For obtaining objective 2, we did archival and field research. Furthermore, we interviewed botanist experts and did a thorough site assessment. For the last objective, we interviewed agricultural course teachers to develop an appropriate list of plants. Next, we developed a students' hands-on activity, designed a three-dimensional model of the organic agricultural learning centre using appropriate computer software and finally created a physical model.

3.1 OBJECTIVE 1: DETERMINE HOW THE LEARNING CENTRE CAN BE APPLIED AND USED WITHIN THE SCHOOL'S EXISTING CURRICULUM

3.1.1 Interviewed the director of Wat Pathumwanaram School

The team first communicated with our project's sponsor, the director of Wat Pathumwanaram School using a semi-standardised, open-ended interview method.⁴¹ We discussed using an informal interview style to receive detailed answers from our sponsor. The key questions were regarding the goal of providing this learning centre in the school, the types of courses related to agriculture currently offered, and the preferred type of agriculture for the centre. The purpose of this interview and discussion was to identify the way to apply the organic agricultural learning centre to the existing school's curriculum. A completed list of the questions for the school director can be seen in Appendix A.

3.1.2 Interviewed an agricultural course teacher at Wat Pathumwanaram School

Apart from meeting with Wat Pathumwanaram School's director, we also interviewed an agricultural course teacher using semi-standardised, open-ended interview method⁴¹ for details on previous courses taught and existing plant houses at the school. The completed list of questions can be seen in Appendix B. Even though the questions were scripted, we usually did not know the contents of their responses. This was to guarantee that our project's objectives were appropriately developed, ensuring that the garden's design would supplement the school's existing curriculum. The interview consisted of current agricultural courses available to students, the grade levels and quota of students eligible to take these courses, and the approximate number of students who annually choose these courses as an elective. Furthermore, the team interviewed the way teachers taught their pupils and how each student was allowed to participate in the schools' currently available agricultural facilities. The objectives of each learning centre and the problems and limitations of each were asked for case study research⁴² to identify the gap from which these learning centres cannot fill. The new model design should be created in a way that any problems or limitations should be considered beforehand, and then built to solve these problems.

3.2 OBJECTIVE 2: IDENTIFY ORGANIC AGRICULTURAL METHODS AND SYSTEMS AS A BASIS FOR THE LEARNING CENTRE

3.2.1 Archival research about organic agriculture strategies

Our team conducted in depth technical assessment of organic agriculture strategies by using archival research.⁴³ The main sections for research topics included organic garden case studies, organic agricultural strategies, factors and tips for organic plant growth. The aim of this step was to get useful information and to obtain basic knowledge on organic agriculture to get ready for further steps.

3.2.2 Interviewed experts in organic agriculture and gardening

The team communicated with two botanical experts at the Department of Botany, Chulalongkorn University: Assist. Prof. Dr. Kanogwan Seraypheap and Assist. Prof. Dr. Yongyuj Chunyaruk using the semi-standardised open-ended interview method.⁴¹ From our previous methodology, where we conducted archival research for organic agriculture strategies, we were able to develop proper more in-depth research questions to the experts. The key questions were about the proper way to do site assessment and suitable organic agricultural methods and systems, including factors that influence plant growth. The completed list of questions can be seen in Appendix C.

3.2.3 Site assessment

After gathering and organizing information from these two sources, we assessed the qualities of the allotted plot of land in order to select suitable types of plants for the land and begin the organic garden's design. This information acted as a guide for our team to know which types of measurements and details for observation are valuable to the design process, *i.e.* land size, sunlight patterns and intensities, average local weather and precipitation, and water sources.

Firstly, site assessment was processed by measuring the plot's dimensions. We collected a soil sample for further consultation with an expert on the type of soil to determine the suitability of this type of soil for plant growth. Sunlight patterns were observed hourly

throughout the whole day by visual observation, paying attention to details such as direction, intensity, area coverage, and time and direction of the sunrise and sunset. We took photos at the same area in the plot of land to further point out the differences of sunlight patterns during the day. Water sources were observed to determine sufficiency and the way the school used water in this land because water is another important factor for plant growth. We calculated the area for water coverage to determine whether or not it was sufficient for plant growth.

3.2.4 Field research at ‘Organic Rooftop Garden—Lak Si’

After procurement of the necessary information from research, expert interviews, and site assessment, our team did case study research⁴³ by going to successful organic garden in Thailand and using archival research to broaden our vision and knowledge of organic agriculture before designing the model. The team went on a field trip to the Naturally Organic Garden Learning Centre: Rooftop Agricultural Garden at Lak Si district, Bangkok. We toured the garden and listed organic plants they have grown successfully on their land. We interviewed Miss Pensri Tosa-ard, a district officer of Lak Si district’s ‘Organic Rooftop Garden’, using the general interview guide approach method.⁴¹ She provided us with valuable information of organic agricultural techniques from her experiences. A completed list of the questions for Miss Pensri Tosa-ard can be seen in Appendix C.

3.3 OBJECTIVE 3: ESTABLISH A PROTOTYPE DESIGN FOR THE LEARNING CENTRE AND EDUCATIONAL MATERIALS TO INTRODUCE ORGANIC AGRICULTURE TO STUDENTS

3.3.1 Interviewed agricultural course teachers for suitable plants

We interviewed agricultural course teachers to edit the list of plants and to ask for their opinions on each plant using close-ended questioning. The open-end questioning method was used to ask for their opinions and for adding the additional edible plants in the list.⁴⁴ The reason for involving these teachers in the design process is due to their role in teaching students organic agricultural methods after the learning centre is constructed in the future. Their opinions for the list of plants were included in the questionnaire. After this step, our team received a list of suitable types of organic plants that the teachers would like to have

in the learning centre.

3.3.2 Developed educational materials for students' activity

The main purpose of the hands-on activity was to introduce organic agriculture to students and to encourage the study of the properties of plants that will be grown in the learning centre. We did archival research to read interesting case studies of hands-on activities for secondary grade students. We chose two activities that were the most interesting and compared advantages and disadvantages of these two activities by doing comparative analysis. The most suitable activity for students in this age group was chosen and was adapted to relate to the organic agriculture model and list of plants.

To gauge the effectiveness of the activity, it was piloted on grade 7 students. We evaluated the activity's success with feedback from agricultural course teachers and participating students. We surveyed teachers using a structured questionnaire and used oral closed-end questions interview for student opinions. We used this technique with teachers because they can provide their level of satisfaction for this hands-on activity and also give comments for further activity improvement. For the students, we used closed-end questions because they are too young to provide detailed comments, so yes or no answers were the best way to communicate with students in this age group to obtain their opinions on the activity.

3.3.3 Designed a three-dimensional model of the organic agricultural learning centre using a computer program

Based on the chosen design concept, we designed a virtual three-dimensional model of the learning centre using a computer program. The three-dimensional model was necessary for putting the exact location of plants and items in the plot of land. We were able to see the overall layout of our design and change the style of our model easily with this computer program. Moreover, it was easier for us to do a physical model later once the model was depicted as a computer image. Before this virtual 3D model was created, we had to consider the exact location of each plant in the area based on all measurements of the land and specific distances that each type of plant needs in order to survive. Then, we designed it by using the Sims⁴⁵, which is a convenient computer program for making virtual three-dimensional models. The program's function is suitable for every age for modern design purposes.

Basically, the program consists of a house-building simulator, such as social life, building structures, gardening, climate, and landscape. The reason the team used the Sims program was because our group consists of students from the Faculty of Science and our knowledge and skills do not quite support the usage of advanced design programs used by architecture students. In addition, limited finances also do not support the usage of more advanced landscape software. Due to the limitations of the program that it could not provide the dimensions, we made a rough drawing of the model on paper providing the correct dimensions. Then, we used the Sims program to simulate the learning centre model to place a representation of plants, a design of the walkway, and other factors required for the learning centre. Another reason that we chose the Sims program was that it was successfully used in the previous Interactive Social and Science Project, involving creating a green area in Wat Pathumwanaram School in 2013.¹⁵

Basic elements to be considered for the design include the landscape, outdoor space areas, and surrounding landmarks or building structures. After these elements were considered, the next step was to plan the design using the scope of the land to guide proper placement of plants. The placement should satisfy both form and function, as well as complete our objectives.

3.3.4 Designed a solid three-dimensional model of the organic agricultural learning centre

We consulted the proper way of doing a solid model with a landscape architecture student at the Faculty of Architecture, Chulalongkorn University. We scaled down the width and length of the plot to make a physical model using a wooden sheet to represent the plot of land. Small sized ceramic plants were bought to act as a representative for each plant. Other small plastic plants were created and painted with different colours to identify each type of plant. Brown coloured clay was used as a base for the soil and scattered over with shredded paper to imitate realistic loam soil characteristics. These plastic plants were placed on top of the soil at their assigned locations, based on the virtual three-dimensional design. A similar physical model was successfully built by the previous Interactive Social and Science Project involving creating a green area in Wat Pathumwanaram School in 2013.¹⁵

CHAPTER 4: RESULTS AND ANALYSIS

This chapter first describes and gives an analysis of the school's agricultural course and existing curriculum. It then outlines the successes and drawbacks of existing agricultural gardens in Wat Pathumwanaram School and details the reasoning behind these results. Following the previous sections, the chapter also discusses organic agricultural methods/systems and environmental factors that are influential to plant growth in the allotted plot of land. This chapter also identifies and examines the final list of appropriate vegetables and herbs, educational materials for the students' activity, and uses all information obtained as a basis for the learning centre to create a realistic design for the allotted plot of land. Lastly, this project delivered three main outcomes, which are all elaborated and discussed at the end of the chapter. Our results are grouped in accordance to our three objectives.

Objective 1: Determine how the learning centre can be applied and used within the school's existing curriculum

Objective 2: Identify organic agricultural methods/systems as the basis for the learning centre

Objective 3: Establish a prototype design for the learning centre and educational materials to introduce organic agriculture to students

4.1 OBJECTIVE 1: DETERMINE HOW THE LEARNING CENTRE CAN BE APPLIED AND USED WITHIN THE SCHOOL'S EXISTING CURRICULUM

4.1.1 Finding 1: The school's curriculum lacks an organic agriculture course for students to experience growing plants from the soil

Through archival research and interviews with Miss Lalita Prasard (Appendix B), we examined the details of the school's curriculum. We found out that the school currently offers two agricultural facilities as electives and basic agricultural courses. None of these options provides organic agricultural knowledge to students; neither do they equip students with hands-on experience on strategies to grow plants using soil-based techniques.

Students have only experienced the hydroponics and mushroom plantations as part of their learning, as these are the only two learning centres available at Wat Pathumwanaram School. Table 3 shows the successes and limitations of these two learning centres.

Table 3: The successes and limitations of the hydroponic plants learning centre and mushroom houses

Learning Centres	Successes	Limitations
Hydroponic Plants Learning Centre	- Students receive hands-on experience of growing hydroponic plants. Students participate at the beginning step of growing plants, sowing seed in beds, transplanting, and maintenance until the products are ready to harvest. - Decreasing school's expenditures. Hydroponic vegetables, including Morning glory, Kale, Lettuce and Green oak are successfully grown and use as ingredients for school lunches and some are being sold to students' parents.	- High cost for water supply, electrical supply, and chemical fertilisers supply. - Vegetables contaminated with chemical substances from pesticides and chemical fertilisers.
Mushroom Houses	- Decreasing school's expenditures. Mushrooms are successfully grown and are used as ingredients for school lunches and some are being sold to students' parents.	- Students cannot participate in every step of the process. The reasons are growing and maintenance of mushrooms are very important and difficult, which have to be done strictly since maintaining good environmental factors are significant for mushroom growth.

Conclusively from these findings, students have opportunities to learn about other agricultural techniques, such as hydroponics and mushroom growing, but not organic agriculture. Wat Pathumwanaram School still lacks an organic agriculture course; therefore, creating an organic agricultural learning centre will provide opportunities for students to experience organic agriculture through hands-on activities.

4.1.2 Finding 2: Secondary grade students have basic knowledge of agriculture

From the interview with Miss Lalita Prasard (Appendix B) and information from using archival research for obtaining the curriculum, we found that secondary grade students (Appendix D) are the specific group of students who will use the organic agricultural learning centre in the future.

Primary grade students (Appendix D) learn how to grow plants in flowerpots in their self-career management course, which is provided one day per week. Meanwhile, secondary grade students learn the basic knowledge of agriculture, hydroponics and mushroom production. Students interested in agriculture are able to choose an agriculture class from a selection of elective courses where in-depth details of agriculture are taught and hands-on activities are provided within the limitations of the school's existing facilities. These students already have sufficient knowledge about agriculture to learn more about different styles and techniques. These findings gave us focus to design an organic agricultural learning centre as a model for secondary grade students rather than primary grade students.

4.1.3 Finding 3: Vegetables are the best choice of organic plants to grow for the benefit of the students and the school

A variety of possible plants can be grown in this plot of land and our findings supported that edible plants are the most beneficial choice for both the school and the student population. According to Table 3, the school benefits from growing hydroponic vegetables and mushrooms for school lunches and selling produce to parents. "Vegetables are the best choice for students and the school to grow on this plot of land," Mr. Sompob Intharachan, the director of Wat Pathumwanaram School, stated in an interview (Appendix A).

4.2 OBJECTIVE 2: IDENTIFY ORGANIC AGRICULTURAL METHODS AND SYSTEMS AS A BASIS FOR THE LEARNING CENTRE

4.2.1 Finding 4: The four main factors that influence plant growth are sufficient in the allotted plot of land

In an interview with Assist. Prof. Dr. Kanogwan Seraypheap (Appendix C), a botanical expert at the Department of Botany, Chulalongkorn University, we found the main factors to observe during site assessment within the plot of land. “The four main factors that influence plant growth are soil, water source, sunlight availability, and natural fertilisers,” she indicated. From information obtained from archival research, interviews with Assist. Prof. Dr. Kanogwan Seraypheap, and site assessment, we can conclude that the plot of land at Wat Pathumwanaram School is suitable for growing edible organic plants.

We found that the type of soil and its depth are important concerns for growing organic plants. An online source indicates that loam soil is preferred to clay soil for growing organic plants. Clay soil would get hard and compact during summer, causing difficulties when turning, and be prone to damage easily during rainy seasons when it gets too wet.⁴⁶ Characteristics of loam soil include having a grainy or coarse appearance, but turn dark brown or black when moist. Loam soil is classified as loose soil and would crumble easily to allow aeration and the spreading of roots.

Fortunately, the school has acquired soil and has filled the allotted plot of land with this soil (Figure 4). After we gathered the soil sample from the site and consulted with Assist. Prof. Dr. Yongyuj Chungyarak (Appendix C), we have confirmed that our soil type is loam soil, which is suitable for growing organic plants. Despite the confirmation, due to time limitations, we have not been able to perform any scientific analysis of the soil. Our team suggests that the school send this soil to be scientifically classified for nutrients present in the soil to the Thailand Land Development Department’s laboratory. Assist. Prof. Dr. Yongyuj Chungyarak also mentioned another aspect concerning soil for organic agriculture is the criteria that organic matter must not be added to the soil for at least three years and additional chemical fertilisers are strictly prohibited. Only natural maintenance of the soil is acceptable for soil used in organic agriculture. Miss Sakorn Boonpeng, who is Wat Pathumwanaram School’s gardener, was there when the soil was added and she (Appendix C) confirmed that

the soil has indeed not been tampered with chemically, and that the soil is indeed suitable for the school's purposes.



Figure 4: Soil at the plot of land

One other important aspect regarding soil is soil depth. From the site assessment, we found out that the school has added loam soil to the plot of land, filling it to a depth of 8 inches. Assist. Prof. Dr. Kanogwan Seraypheap (Appendix C) mentioned during a consultation that “a suitable depth for the soil should measure up to 4 inches.”

From all these information acquired through site assessment, archival research, and consulting with botanical experts, we came to a conclusion that the available soil is suitable for organic plants' growth. The soil's type is classified as loam soil, which is preferred for growing organic plants and its depth all corresponded with the criteria for growing plants organically.

Water

The next significant factor, water, has to be considered when designing the organic agricultural learning centre. Assist. Prof. Dr. Kanogwan Seraypheap said (Appendix C), “Organic plants have to be watered frequently, thus sufficient water sources in the allotted plot need to be identified.” Only one water source was found during the site assessment, a single tap, which is connected to a rubber hose long enough to spray water to the plot of land. It does not have full area coverage for watering organic plants, so as a result, an alternate watering method is required for the learning centre.

Table 4: Sunlight patterns at the plot of land

10:00 AM; SHADY, SUNLIGHT BLOCKED BY TALL BUILDINGS SURROUNDING THE AREA	
	
11:00 AM; SUNLIGHT PRESENT IN THE CENTRE OF THE PLOT	
	
12:00 PM; STRONG SUNLIGHT SPREAD THROUGHOUT ALL AREAS	
	

13:00 PM; STRONG SUNLIGHT SPREAD THROUGHOUT ALL AREAS	
	
14.00 PM; SUNLIGHT INTENSITY NOT AS STRONG AS 13:00 PM BUT IS STILL SPREAD THROUGHOUT ALL AREAS	
	
15:00 PM; SOFT SUNLIGHT, DOES NOT COVER ALL AREAS	
	

16:00 PM; SOFT SUNLIGHT, DOES NOT COVER ALL AREAS	
	
17:00 PM; BARELY ANY SUNLIGHT LEFT	
	
18:00 PM; NO SUNLIGHT	
	

The last significant factor for plant growth is sunlight. According to Assist. Prof. Dr. Kanogwan Seraypheap, “Sunlight area coverage during the day needs to be considered for choosing types of organic plants and assigning them in their most suitable areas.” (Appendix C)

From the site assessment, we found that the plot of land receives most of its light source during 11 AM-4 PM (Table 4). The school’s location also majorly affects the land’s

sunlight hours because of tall buildings permanently residing in both East and West directions of the school (Appendix E). These buildings block most of the sunlight during morning hours and evening hours. After we consulted with Assist. Prof. Dr. Yongyuj Chunyarak (Appendix C), we found that 5 hours (11AM-4 PM) is sufficient for growing organic plants.

After considering these four main factors (soil, fertilisers, sunlight, and water source) and in conjunction with advice from botanist experts, we found that both soil and sunlight are suitable and sufficient for growing organic plants in the allotted plot of land. However, an additional water source was suggested in the learning centre's model to eliminate insufficient water area coverage problems.

4.2.2 Finding 5: Nursery plant beds, mature beds, and intercropping are suitable organic agricultural methods and systems

After interviewing Assist. Prof. Dr. Kanogwan Seraypheap and conducting field research at the 'Organic Rooftop Garden', we were able to conclude the most suitable organic methods and systems for the plot of land.

The organic agricultural learning centre is designed to highlight the principle of sustainability. Growing plants organically will make practical use of the sustainability principle by following the concept of using naturally available resources to aid plant growth. Therefore, strategies of organic plant growth must be accounted for when designing the model for long-term usage.

We accumulated information from various sources as the basis for the organic agricultural learning centre. First, we found out about the necessity of incorporating nursery plant beds, which are vital for a fruitful plant growth yield. Assist. Prof. Dr. Kanogwan Seraypheap stated in an interview, "Organic nursery plant beds are required apart from mature plant beds." (Appendix C)

These nursery plant beds are used to grow young plants in a more shady area before moving them to the main plant beds to avoid premature death. These young plants are generally weak and without nursery plant beds to protect them from adverse temperatures,

heavy rains, and wind, young plants may die. Nursery plant beds are also necessary to avoid competition for nutrients. “Without nursery plant beds, the ones that receive more nutrients survive and grow into a full plant while others do not achieve a full growth cycle and die eventually,” (Appendix C), Miss Pensri Tosa-ard, a government officer of Lak Si district at ‘Organic Rooftop Garden’ explained in detail. Since young plants do not require a large amount of sunlight, to solve this problem, our design includes a nursery plant bed placed in a shady area of the plot of land. This method is suitable for all organic plants.

To design areas for mature plant beds, suitable sizes have to be researched and considered beforehand. Miss Pensri Tosa-ard indicated, “50-70 cm width between each plant bed is a proper distance for a walking area between beds. The suitable width for beds should be around 1.20 m for ease in taking care of plants in each bed and the bed’s length depends on your plot’s size.” This information was confirmed with an earlier interview from with Assist. Prof. Dr. Kanogwan Seraypheap (Appendix C), a botanical expert at Chulalongkorn University, where he mentioned the same details for organic plant growth strategies. Evidence from this case study and interview was considered to design plant bed’s dimensions. Furthermore, Miss Pensri Tosa-ard suggested that many kinds of plants should be grown in one bed to avoid critical damage from pests because each kind of pest eats different kinds of plant. So, our design model alternates growth between two different types of plants assigned in each plot to partially negate devastation that a pest outbreak could cause.

4.3 OBJECTIVE 3: DEVELOP A PROTOTYPE DESIGN FOR THE LEARNING CENTRE AND EDUCATIONAL MATERIALS TO INTRODUCE ORGANIC AGRICULTURE TO STUDENTS

4.3.1 Finding 6: The organic plants to be grown on the plot of land will consist of a variety of vegetables and herbs

To find appropriate organic plants for the plot of land, the team did archival and field research at ‘Organic Rooftop Garden’ on list of organic plants compatible with Bangkok weather conditions. We obtained a list of 34 plants in total and all of them are edible plants: Chinese radish, Pak chai, Celery, Spring onion, Spinach, Amaranth, White mugwort, Bean sprout, Bird’s eye chili, Sweet chili, Bitter melon, Bitter melon, Bitter melon, Kumquat, Lime, Kaffir lime, Centella, Kariyat, Chinese bean, Longlived cabbage, Chinese cabbage, Kale, Gourd, Spring

bitter cucumber, Bitter cucumber, Lettuce, Kai-Lan, Chinese mustard green, Pea aubergine, Holy basil, Ivy gourd, Bottle gourd, Lemongrass, Coriander and Thai aubergine.

We consulted with experts to further narrow down this list. Assist. Prof. Dr. Kanogwan Seraypheap (Appendix C) considered the four main factors from the site assessment and cut some edible plants from this list to 11 plants, which are Bird's eye chili, Holy Basil, Sweat basil, Kale, Pea aubergine, Chinese cabbage, Banana, Galingale, Lemon basil, Lemongrass and Goat peppers. The reason for narrowing down plants in the list was due to difficulties in maintenance for several types of plants. These difficulties will deprive the students of any involvement in the learning centre, which would decrease the efficiency for student participation.

Furthermore, Assist. Prof. Dr. Yongyuj Chunyarak (Appendix C) indicated that; "This plot of land is suitable not only for vegetables but also herbs because the quality of the two main factors, soil and sunlight are sufficient. Herbal plant growth is easier in terms of maintenance and probability for survival." Professor Yongyuj suggested suitable herbal plants, which included Aloe Vera and Fah Talai Jone for this learning centre.

After narrowing down the plant list from interviews with botanist experts, we researched each type of plant to list each plant's properties and special sensitivities to consider their environmental factors. Sunlight and shady areas for growing plants were researched for careful consideration because some plants need a lot of sunlight, while others may not or prefer only shady areas. Properties of each plant were also researched because we want the best utilization for the plot of land by planting edible plants as the majority.

After we obtained a list of prospective appropriate plants with their properties included, another consideration to finalise the list of organic plants was the opinions of the school teachers. Agricultural course teachers at the school will have to directly use the organic agricultural learning centre. These teachers will be responsible for providing organic agricultural knowledge to students, as well as explain the properties and characteristics of the plants grown there. Equipped with the basic knowledge of organic agriculture, students can then be allowed to participate in the organic agricultural learning centre.

Agricultural course teachers recommended adding two plants to the list, which are Ginger and Morning glory, and also suggested limiting the number of herbal plants because despite being functional as part of the curriculum, herbal plants cannot be used for school lunches. Instead, selected vegetables and plants that are currently grown in the hydroponics plantation area, namely Morning Glory and Cabbages, should be included in the organic learning centre. These groups of plants will be used to teach students to compare and contrast agricultural methods and techniques, *i.e. organic technique* and *hydroponics technique*.⁸ Following these methods, the final list of appropriate organic plants was successfully derived as shown in Table 5. The properties of each plant can be seen in Appendix F.

Table 5: The final list of appropriate organic plants

List of Appropriate Plants
1. Bird's eye Chili
2. Holy basil
3. Sweet basil
4. Kale
5. Pea aubergine
6. Morning glory
7. Chinese cabbage
8. Banana tree
9. Ginger
10. Galingale
11. Lemon basil
12. Lemongrass
13. Goat pepper
14. Fah Talai Jone
15. Aloe vera

4.3.2 Outcome 1: The ‘Organic Plants Hunter Game’ was developed successfully as a suitable activity to complement the organic agricultural learning centre

Without any introduction to organic agriculture, students in Wat Pathumwanaram may not express interest on the topic. These students currently do not even know about the received adjacent plot of land. After discussion with the director of Wat Pathumwanaram School, he said (Appendix A), “A hands-on activity is needed to inform students of the received adjacent plot of land due to the fact that it will become an organic agricultural learning centre in the future. The activity should provide basic knowledge of organic agriculture and educational materials should be made to suit this purpose.”

As an activity to complement the organic agricultural learning centre to introduce organic agriculture to students, we used archival research to find an idea for a game that would be both educational and enjoyable. To create an interesting and effective hands-on activity complementary to the organic agricultural learning centre, we did research to find previous activities suitable for secondary grade level students. An interesting activity we found appropriate for students at this age group is called the Group Scavenger Hunt Game.⁴⁷ This game may not be directly related to organic agriculture, but through adaptation, it can be used as a hands-on agriculture activity.

The game’s instructions are simple, yet the game itself may be created as a hands-on educational tool. To play the Group Scavenger Hunt Game, pupils are divided into groups of four or more. Each group will receive the same list of items and the group with the quickest time to bring those items back will win the game. Alongside bringing back those items, each group is expected to use resources in their surroundings efficiently. Trickier items may be placed in order to make the game more challenging.

The concept of the Group Scavenger Hunt Game was adapted for our team’s hands-on educational activity. Our team was interested in this activity because it showed effectiveness in making students get the overall picture of complicated topics, which means that we can adapt this game to relate to the organic agricultural learning centre’s model. The team created an adaptation of the Group Scavenger Hunt to create our own Organic Plants Hunter Game. The main objectives of the Organic Plants Hunter Game are for students to provide group contributions, exhibit resourcefulness during gameplay, and explore their creative thinking

skills. Before finalizing the game's parameters, our team interviewed all related agricultural course teachers in Wat Pathumwanaram School. The teachers all gave the same response when asked if an activity like this was ever done in school or incorporated into their teaching curriculum before. "We have never provided activities to students just yet. Most educational styles in school were done the conventional way—through the classroom's lectures," Miss Lalita responded (Appendix B).

Regarding students in the secondary level, Miss Bunga Worakit mentioned (Appendix B), "Students in this age group love the idea of competition. Separating the group of students into teams would be one the most effective ways for them to show interest in taking in the information we were about to provide and for letting the students know how to work as a team. The students will also want to put effort to win against other groups."

We asked for details regarding the difficulties of games that secondary students can deal with and Miss Lalita said (Appendix B), "The level of difficulty should be determined in this activity as well and it should be suitable for students in the intermediate level. Students in these grade levels will only focus in a limited amount of time and will not participate if the activity is too boring or too hard for them."

Through interviews, our team incorporated the teachers' ideas and opinions into our Organic Plant Hunter Game and came up with a finalised idea for the educational activity. The Organic Plant Hunter Game was then conducted at Wat Pathumwanaram School. We started off by giving students an introduction about organic agriculture, started the game, then conducted an evaluation (Appendix G) to see if our activity met its objectives: teamwork, plants and its properties, and organic agriculture. To conclude, the activity achieved the objectives that our team set for the game, which was to introduce organic agriculture to students. Detailed instructions on the Organic Plants Hunter Game can be seen in Appendix H.

4.3.3 Outcome 2: The prototype was designed in virtual model form, using all information obtained as a basis for the design

After we conducted research for easy and suitable computer software for designing the prototype of the organic agricultural learning centre, the Sims program⁴⁵ was selected from several other programs because of its ease of use for amateur landscape garden designers. We used the information obtained from all our research and findings to assist in the design. The landscape, its environmental factors, and other details were used as a basis for the design. Environmental factors, such as sunlight patterns, were significantly considered for suitable placement of nursery plant beds, mature plant beds, and types of plants. Plants that require more water were placed closer to the water source. Plants that require more sunlight were placed in the middle of the model due to strong sunlight intensity.

Due to the limitations of the program that it could not provide dimensions, we made a rough drawing of the model on paper providing the correct dimensions. A paper-based sketch of the model could not help us visualise how the organic agricultural learning centre was going to look like, so a three-dimensional form of the model's design was required for adjustments.

We used the Sims program to simulate the learning centre's model in three-dimensional form and specified the locations of plants, nursery plant beds, water sources, and walkways. We altered the design to develop the best design that is suitable for being a learning centre, as well as the utilizing the land efficiently. The length of the walkway was significantly changed from 30 cm to 60 cm. Even though the small sized walkway (30 cm) would be more efficient for growing more plants and one way to utilise the land efficiently, this design was not suitable for being a learning centre. Since several students will be allowed inside the learning centre, a 30 cm-walkway would be too narrow to them to walk pass each other. A widened walkway would provide more space for students to move around without damaging plant beds and to maintain plants. Because of these reasons, we widened the walkway's length to 60 cm and added more walkways between each plant bed to improve the effectiveness for plants' maintenance by the students. A rough drawing of the design on paper and the three-dimensional prototype model using the Sims computer software developments can be seen in Appendix I and the finalised virtual model design can be seen in Figure 5.



Figure 5: Finalised virtual model designed in the Sims computer software

4.3.4 Outcome 3: The physical model of the organic agricultural learning centre

This model was required to fulfill the project's goal because it was used as a representation of the future organic agricultural learning centre. The model will enable our sponsor to see the whole picture and details in the design. Our sponsor can then use this model to acquire funding in order to build the learning centre in the near future. Since this model was created based on influential factors for the growth of plants, efficiency for plants maintenance, and application as a learning centre for students, this model is the best way to represent our team's idea to efficiently utilize the received adjacent land into an organic agricultural learning centre.

After we consulted with a landscape architecture student⁴⁸ from the Faculty of Architecture, Chulalongkorn University, on doing landscape garden design, we found the suitable scale of the model and the way to create small items, such as artificial shrine, plants, fence and walkway. Some materials used in the organic garden's physical model were brought from Chatuchak market and the art supply store at the Faculty of Architecture. Tiny plants acquired from Chatuchak market more closely represented the actual plants than the Sims model. The physical model's base consisted of wood, clay and artificial soil. Then, after we prepared the base, tiny plant models were carefully laid out as designed. The shrine and other decorations were put in their designated locations. The purpose of the physical model

was to recommend our sponsor on utilizing the plot of land with the highest benefits efficiently. The finalised physical model design of the organic agricultural learning centre can be seen in Figure 6.



Figure 6: Finalised physical model designed of organic agricultural learning centre

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

Upon completion of this project, the school was able to integrate organic agricultural techniques into their existing agricultural courses through the use of a developed educational hands-on activity and a model of the organic agricultural learning centre. This was achieved by doing archival research, interviews with botanical experts and organic agricultural course teachers, and site assessment. This chapter begins with a summary of our project outcomes regarding the organic agricultural garden system design and the conclusions drawn from our findings. This is followed by our recommendations for utilizing the garden for educational and social purposes.

5.1 SUMMARY OF FINDINGS

Through our archival research, experts' interviews, and site assessment, we were able to achieve four main objectives. These include incorporating the existing school's curriculum to the organic agricultural learning centre, identifying suitable organic agricultural systems and methods for the plot of land, establishing the learning centre's design in physical three-dimensional form, and organizing a piloted and evaluated educational activity for Wat Pathumwanaram School.

5.1.1 The Organic Agricultural Learning Centre is Applicable for the Existing School's Curriculum

From conducting interviews and archival research, we found that the school can apply this organic learning centre into the school's curriculum. We discovered that the school's curriculum provides basic agriculture knowledge to primary and secondary grade students. Only secondary grade students, however, were allowed the opportunities to participate in agricultural hands-on activities, such as the school's hydroponics plantation and mushroom houses. The school's curriculum still lacks providing hands-on experience on organic agricultural techniques to students.

5.1.2 Organic Agriculture Systems and Methods

Through interviewing botanical experts, we found out about four main factors that influence plant growth. These factors are suitable types of soil, sufficient water sources, sunlight patterns and intensity, and natural fertilisers using compost. We discovered that loam soil is the most suitable type of soil for organic agriculture. Each type of plant is specifically sensitive to sunlight intensity and water supply, thus extra care for locating each type of plant is a necessity for successful plant growth. We also found that fertilizing naturally and organically with compost is the main factor required to grow organic plants that is independent from the use chemical substances.

5.1.3 The Prototype Design of the Organic Agricultural Learning Centre

To consider the prototype of the organic agricultural learning centre, we were ensured from our site assessment and consultation with botanist experts that the plot of land is suitable for organic agriculture, which was considered using the four main factors as the criteria. The type of soil, water source, sunlight, and availability of compost were studied as the basis for the learning centre. We also discovered appropriate edible plants to form a list that would provide beneficial knowledge to the students and also fit into the school's curriculum.

The team discovered the design of an organic agricultural learning centre with a driven incentive to introduce organic agriculture to students at Wat Pathumwanaram School. The organic agricultural learning centre was designed for optimum efficiency and utilization, with carefully considered ease of allowing student involvement and application for the organic plants grown.

Nursery plant beds, mature plantations, walkways, and water sources were strategically positioned to correspond to accumulated research information. Shadier areas will accommodate nursery plant beds, while areas thoroughly exposed to sunlight are plantations for mature plants. The composition of the walkway was designed so students could effortlessly take care of every plantation and harvest their produce.

After a prototype design for the learning centre was developed, constructing the organic agricultural learning centre's model was the conclusive tangible outcome of our design. The final layout of the design is presented in Figure 5 and 6.

5.1.4 Educational Activity for Providing Basic Organic Agricultural Knowledge to Secondary Students

To foster further student participation for their future organic agricultural learning centre, our team also developed an exploratory educational activity to complement our aim in introducing organic agriculture to students. Through online research, we discovered an effective complimentary activity that can be adapted to the organic agricultural learning centre called the Group Scavenger Hunt, which is deemed suitable for secondary grade students. Using our research as a basis for developing the game, we created the Organic Plants Hunter Game (Appendix H). The game successfully provides basic organic agriculture knowledge and edible plants' properties and features to students.

5.2 RECOMMENDATIONS

As a result of the analysis that we conducted throughout our project, we were able to make recommendations for project continuation at Wat Pathumwanaram School. These recommendations may also benefit similar projects in schools elsewhere that may want to provide their students with an organic agricultural learning centre. The following recommendations describe ways to maintain the learning centre for current and future student generations, evaluation of educational uses of the learning centre, and then propose ideas for practical knowledge application outside the students' classrooms.

5.2.1 Organic Agricultural Learning Centre Maintenance

Garden maintenance requires a considerable amount of effort and cooperation from the school for proper upkeep, a compost program, and garden maintenance. We recommend that the school involve the student population to take major responsibility in garden maintenance. This way, two objectives can be attained. Alongside having the organic agricultural learning centre being tended to, students can also take this opportunity to gain

invaluable organic agricultural experience. The team recommends garden maintenance knowledge should be provided to students in existing organic agricultural course to ensure that students can participate in doing maintenance in the learning centre.

To ensure a sustainable continuation of the future organic agricultural learning centre, we recommend having a compost program using available resources in surrounding school areas. We recommend that unused mushrooms from the mushroom shed could be used as organic matter to provide proper nutrients for the soil. The school can easily make compost from the unused mushroom by fermentation for two weeks and then leave it in the soil for another two weeks before planting. Without even having to purchase new materials, the school is able to circulate agricultural materials within their own ecosystem to create an effective sustainable organic agricultural learning centre.

5.2.2 Using the Organic Agricultural Learning Centre's Model as an Educational Aid for Students

We recommend that the school use the organic agricultural model as an educational material for students. We conclude that it is an effective teaching technique for teachers to use it to teach the organic agricultural system and factors influencing the growth of plants. Using the model as an educational material, students will be able to see the overall picture of the garden, as well as details of an organic agricultural system in 3-dimensional form. Moreover, this model is also suitable for teaching young students in the primary grade level because a 3-dimensional model is more interesting than flat textbooks.

5.2.3 Teaching the Differences Between Organic Agricultural Techniques and other Agricultural Techniques through Hands-On Experience

Our findings show that a hydroponic learning centre and mushroom houses already exist within the school. We recommend that teachers must allow students to compare these agriculture techniques with organic agriculture, using the same types of plants. Students would then see the differences in agricultural techniques through observation of the produce and the length of harvest on these techniques. We can conclude that students would more easily understand the advantages and disadvantages of different agriculture techniques because they have opportunities to compare and contrast an additional agricultural technique.

5.2.4 Incorporation of the School's Organic Agricultural Learning Centre into Nearby Communities

We recommend that after Wat Pathumwanaram School maintains the organic agricultural learning centre to an extent, they may bring parents and people in nearby communities to participate in the organic agricultural learning centre. After the organic agricultural learning centre has been fully incorporated into the school's curriculum, we advise that the school should promote and raise awareness of the organic agricultural learning centre's existence to students' parents by having students inform their parents. For nearby communities, the school may promote the organic agricultural learning centre by creating a poster placed in front of the learning centre's entrance in order to attract interested participants.

We suggest the school to provide courses for both students' parents and people in nearby communities on weekends in order to educate and spread methods of growing organic plants. The school should also teach these groups of people how to maintain organic plant growths using the sustainability concept, by encouraging the use of available resources or reusable items. Our findings show that organic agriculture can be successfully developed and maintained in a small area within an urban community. Thus, parents and nearby communities may learn from this model learning centre and grow organic plants at home or sell products to find additional sources of income.

REFERENCES

- [1] Thai Organic Trade Association. Overview of organic agriculture in Thailand.
<http://www.thaiorganictrade.com/node/442> (accessed 29/09/11).
- [2] Grace Communications Foundation. Sustainable table-organic agriculture.
<http://www.sustainabletable.org/253/organic-agriculture> (accessed 21/06/08).
- [3] Thaiger. Organic gardening.
<http://forums.organicgardening.com/topic/51820721209312392> (accessed 09/11/12).
- [4] Marie, I. Gardening. <http://gardening.about.com/od/gardenprimer/f/OrganicGarden.htm>
(accessed 07/08/12).
- [5] Rajamangala University of Technology Phra Nakhon. Follow the royal footsteps.
<http://www.rmup.ac.th/en/2011/05/follow-the-royal-footsteps/> (accessed 24/05/11).
- [6] K Nation block. Agribusiness and tropical agricultural resource management.
<http://www.oknation.net/blog/Chowda-Mamutipong/2009/01/08/entry-5> (accessed 08/01/12).
- [7] The Projects Initiated by H.R.H Princess Maha Chakri Sirindhorn.
<http://www.sirindhorn.net/HRH-projects.en.php> (accessed 09/07/12).
- [8] The Government Public Relations Department. The new theory and the sufficiency economy. http://thailand.prd.go.th/ebook/king/new_theory.html (accessed 2010).
- [9] Manh, H. King Bhumibol's philosophy of sufficiency economy for Thailand
<http://english.vov.vn/Society/International-Cooperation/King-Bhumibols-philosophy-of-sufficiency-economy-for-Thailand/254213.vov> (accessed 2012).
- [10] Anurak Thailand Tourism. H.M. King Bhumibol's philosophy of sufficiency economy.
http://www.thaiwaysmagazine.com/thai_article/2413_sufficiency_economy/sufficiency_economy.html (accessed 2002).
- [11] Praty, P. Education with sustainability in Thailand
www.loeitech.ac.th/web/news/2553/popeng.htm (accessed 02/04/10).
- [12] Education with sustainability in Thailand. www.moe.go.th/charuaypon/works
(accessed 22/08/13).
- [13] Royal Thai Government. Education with sustainability in Thailand.
www.thaigov.go.th/th/news-ministry/2012-08-15-09-39-20/item/10414-.html (accessed 15/01/14).
- [14] Ken, M. Transforming lives.
<http://www.bangkokpost.com/education/site2007/cvvn0607.htm> (accessed 06/11/07).

- [15] Chaianuchittrakul,C.; Tantakool,C.; Songprasertkul,P.; Traiworakul,T.; Riwkulkajorn,P. Create a green area with an appropriate ecological system and ensure that the maintenance of the garden is sustainable. *Interactive Social and Science Project*. **2013**.
- [16] Horne, P. Integrated pest management for crops and pastures. *CSIRO Publishing*. **2008**.
- [17] Helga, W. Organic agriculture. Excellence for sustainability. www.fibl.org (accessed 11/01/14).
- [18] United Nations Escap. The role of agricultural and rural development in Thailand. www.unescap.org/rural/doc/oa/Thailand.PDF (Accessed 3/2/11)
- [19] Earth Foundation. Hivos people unlimited. www.hivos.nl/dut./community/partner/10006973 (Accessed 28/2/13)
- [20] WikiHow. How to start an organic vegetable garden. <http://www.wikihow.com/Start-an-Organic-Vegetable-Garden> (accessed 07/03/12).
- [21] Factors affecting plant growth. <http://broome.soil.ncsu.edu/ssc051/Lec3.htm> (accessed 01/04/13).
- [22] Taylor, A. O.; Rowley, J.A. Plant under climatic stress. *Plant Physiol*. **1971**, 47.
- [23] Shinji, T. Effect of various radiant sources on plant growth. http://www.trymax.co.kr/demo/pt/pt_13.htm (accessed 18/12/98).
- [24] Alycia, B. Organic gardening. <http://www.examiner.com/article/40-fruits-vegetables-and-herbs-that-will-grow-partial-shade> (accessed 24/03/11).
- [25] Plant and soil elibrary. Soil organic matter. <http://passel.unl.edu/pages/informationmodule.php?idinformationmodule=1130447040&topicorder=6&maxto=8> (accessed 09/04/14).
- [26] Smith, J.; Nasr, J.; A. Ratta. Urban Agriculture. *The Urban Agriculture Network*. **2001**.
- [27] Lee-Smith, D. Cities feeding people: an update on urban agriculture in equatorial Africa. **2010**, 22, 483-499.
- [28] Mougeot, L. Growing cities, growing food. **2000**, 1-42.
- [29] Van, B.; Hartig, A. E.; Staats, H. Preference for nature in urbanized societies. **2007**, 63, 79-96.
- [30] Baker, C.; Pasuk, P.A. History of Thailand. **2009**, 199.
- [31] Wikipedia. <http://en.wikipedia.org/wiki/Bangkok> (access: 22/01/13).
- [32] Nan, S. http://travelthailandwatpo.blogspot.com/2011/02/chao-phraya-river_21.html (accessed 2011).
- [33] Department of Mineral Resource. Thailand geology. www.dmr.go.th/ewtadmin/ewt/dmr_web/main.php?filename=central_geo (access: 15/03/03).

- [34] World weather and climate information. Average weather in Bangkok. www.weather-and-climate.com/average- (accessed 2013).
- [35] Thai Metrological Department. Information centre. www.tmd.go.th/thailand.php (access: 09/02/03).
- [36] Natural Organic Matter. Green facts. www.greenfacts.org/glossary/mno/natural-organic-matter-NOM.htm. (accessed 22/04/2007).
- [37] Steve, C. Stochastic Synthesis of Natural Organic Matter. <http://www.cse.nd.edu/~nom/Papers/ASLO2.pdf> (assessed 22/07/07).
- [38] Hargitai, L. The soil of organic matter content and humus quality in the maintenance of soil fertility and in environmental protection. *Landscape and Urban Planning* 27:161–167.doi:10.1016/0169-2046(93)90044-E (accessed 1993).
- [39] Zemanek, P. Evaluation of compost influence on soil water retention. http://www.mendelu.cz/dok_server/slozka.pl?id=51329;download=77592 (assessed 2011).
- [40] Pottorff, L.P. Colorado State University Cooperative Extension. Some pesticides permitted in organic gardening. <http://www.colostate.edu/Depts/CoopExt/4DMG/PHC/psticid2.htm> (assessed 2010).
- [41] Dapzury, V. Types of interviews. <http://www.public.asu.edu/~kroel/www500/Interview%20Fri.pdf> (accessed 2010).
- [42] Sue, S. The case study as a research method. <http://www.ischool.utexas.edu/~ssoy/usesusers/l391d1b.htm> (accessed 02/12/06).
- [43] Tarun, T. Online research methodology. <http://bcjms.bhattercollege.ac.in/online-research-methodology-using-the-internet-and-the-web-for-research-and-publication/> (Accessed 06/12/12).
- [44] Ryan, V. How to carry out a questionnaire. <http://www.technologystudent.com/designpro/quest1.htm> (accessed 01/03/02).
- [45] The Sims. <http://www.thesims.com> (accessed 04/08/13).
- [46] Leineriza, L. Growth as nature intended. <http://agverra.com/blog/soil-types/> (accessed 07/04/11).
- [47] Teacher Education in sub-Saharan Africa. Investigating materials. http://www.ufh.ac.za/faculties/edu/tessa/Resources/Science/SCI_M2_S1_RSA_HANDOVER_Describing_and_sorting_substances.pdf (accessed 06/09/12)
- [48] Sengpairroh, S., personal communication.

APPENDIX A: SEMI-STRUCTURED INTERVIEWS AND RESPONSES WITH DIRECTOR OF WAT PATHUMWANARAM SCHOOL

Note: *All of the following interviews were conducted in Thai and later translated to English.*

Interview with Mr. Sompob Intharachan: Director of Wat Pathumwanaram School

Attendees - *Kunaporn Kittisopidadit, Thanida Dangprasert, Lalita Radtanajiravong,*

Varinporn Lerdpornchareon, Kroerit Maneejak, Woojin Park

Monday, 20 January, 2013 at 1:00 PM

From this organic agricultural learning centre, what is the best type of plant for students and the school?

According to the school curriculum, vegetables are the best choice for students and the school to grow on this plot of land.

What is the school's idea of sustainability?

I want the team to plant edible plants to show the differences between hydroponic and organic gardening. Moreover, I want to use these edible plants for school lunches.

Considering the available activities in their current curriculum/learning centre, what kind of activities would the school want us to provide in order to add up to their school curriculum?

A hands-on activity is needed to inform students of the received adjacent plot of land due to the fact that it will become an organic agricultural learning centre in the future. The activity should provide basic knowledge of organic agriculture and educational materials should be made to suit this purpose. Any activity that might give inspiration to students, help them to love nature and understand more about organic agriculture.

How much time would students have to participate in the available activities provided in the learning centre?

I am not entirely sure about the schedule for students. Therefore, the school will find suitable time for the team to do activities with students.

APPENDIX B: SEMI-STRUCTURED INTERVIEWS AND RESPONSES WITH TEACHERS

Note: *All of the following interviews were conducted in Thai and later translated to English.*

Interview with Ajarn Lalita Prasard: Agricultural course teacher at Wat Pathumwanaram School

Attendees - *Kunaporn Kittisopidadit, Lalita Radtanajiravong, Varinporn*

Lerdpornchareon, Thanida Dangprasert, Kroerit Maneejark

Friday, 29 November 2013 at 10:00 AM

How many students does the school have and how many classes are taking agricultural course activities?

Wat Pathumwanaram School has a total number of 770 students, from elementary school (1st grade) to the intermediate level (8th grade).

What is the majority of the parents' occupation?

These students come from similar family backgrounds. Most parents have jobs near the school's surrounding areas (shop keepers, maids, workers around Siam Paragon or Central World); a few parents work for the government with slightly better pay.

Does the school have other agricultural projects and do these projects have any problems?

Wat Pathumwanaram School has two main agriculture-related facilities. These facilities are provided to students as part of their curriculum as a general education course for interested students. These two main facilities are:

Hydroponics plantation: This plantation uses natural extracts to grow plants, including morning glory, kale, lettuce, tomatoes, green oak, to name a few.

Purpose: Used as ingredients for food and lunch provided to students in the school and some are being sold to students' parents

- Provide knowledge as well as encourage students the concept of growing plants without using dirt or soil

Students who select this course will have to take responsibility for watering the plants and adding essential minerals for plant growth to the soil.

Problems: Insects and pests, water pumping system failure

Two mushroom houses:

Purpose: Used as ingredients for food and lunch provided to students in the school and some are being sold to students' parents; promote and provide knowledge about mushroom growing to students

Problems: For this project, students will not get to be involved as much because it is quite difficult to maintain and take care of.

Does the school have a compulsory curriculum for agricultural projects? If so, how many students currently attend this class?

Classes taught with subjects related to agriculture are provided to students in the secondary level (220 students). Students can select majors, of which, some majors will consist of agriculture as a mandatory class, while others may be optional.

For majors with agriculture as a mandatory class, students will study basic foundation for agriculture according to the curriculum, but will not get to receive hands-on experience. Students who choose to study agriculture as a general elective will be able to get hands-on experience with available agricultural facilities in the school.

From question 4, what is the objective of the provided agricultural activities and what does the school expect from this project?

1. Promote agricultural activities to elementary students with organic gardening/farming as the main topic
2. Beneficial plants that students will be able to use for food and sold to parents

In the case that edible plants may not be grown in the provided area (adjacent land received by the school), then beautiful flowers may be grown in that area instead for decorations for future school activities.

Interview with Miss Lalita Prasard, Miss Bunga Worakij, Miss Jiratchaya Chobtum, and Miss Tunyanun Punsed: Agricultural course teachers at Wat Pathumwanaram School

Attendees - Kunaporn Kittisopidadit and Varinporn Lerdpornchareon

Wednesday, 5 February 2013 at 10:00 AM

Do you have any suggestions or comments for this list of plants?

Miss Lalita Prasard

I think this list of plant is okay but you should limit the number of herbal plants because they can be used only for one purpose, which is teaching students and they cannot be used for school lunches. Moreover, Morning glory is the good choice because it is currently grown in the hydroponic learning centre, so it can be used to teach students to compare and contrast agricultural methods and hydroponic plantation technique.

Miss Bunga Worakit

I think that you should add Ginger into the list because it can be used for school lunches and it is interesting to teach its growth to students.

Miss Jiratchaya Chobtum and Miss Tunyanun Punsed

I have no further suggestions for other plants to add but I am rather satisfied with the list and think that these plants should be beneficial knowledge to students at the school.

Were there ever any activities related to agriculture provided to students?

Miss Lalita Prasard

We have never provided activities to students just yet. Most educational styles in school were done the conventional way—through the classroom's lectures.

Miss Bunga Worakit

The school never had any activities about agriculture before. Some lectures about agricultural tools have been given but they are not activities.

What grade are you teaching and what is the content used for teaching agriculture course?

Miss Lalita Prasard

I am teaching hydroponic and mushroom plantation in grades 7, 8 and 9.

Miss Bunga Worakit

I am teaching basic agricultural knowledge to students in grades 1 and 2.

What criteria of game do you think the team needs to consider for making it suitable to secondary grade students?

Miss Lalita Prasard

The level of difficulty should be determined in this activity as well and it should be suitable for students in the intermediate level. Students in these grade levels will only focus in a limited amount of time and will not participate if the activity is too boring or too hard for them.

Miss Bunga Worakit

Students in this age group love the idea of competition. Separating the group of students into teams would be one the most effective ways for them to show interest in taking in the information we were about to provide and for letting the students know how to work as a team. The students will also want to put effort to win against other groups.

Interview with Miss Lalita Prasard and Miss Bunga Worakit: Agriculture teachers at Wat Pathumwanaram School

Attendees - Kunaporn Kittisopidatit, Lalita Radtanajiravong, Varinporn Lerdpornchareon, Thanida Dangprasert and Kroerit Maneejark
Friday, 18 February 2013 at 1:00 PM

According the evaluation score, these teachers have rated the activity's material as 3 out of 4. We asked for any improvements in order to improve the materials.

Miss Lalita Prasard

The activity's materials are pictures and words that were printed out, which were not attractive to the students. It should be something interactive, such as a video clip on a TV screen in order to engage students in the activity.

Miss Bunga Worakit

I think the activity was interesting enough to secondary grade students because most students participated well. If the school wanted to use this activity in long-term, the school should improve the quality of the educational materials.

APPENDIX C: SEMI-STRUCTURED INTERVIEWS AND RESPONSES WITH EXPERTS

Note: *All of the following interviews were conducted in Thai and later translated to English.*

Interview with Assist. Prof. Dr. Kanogwan Seraypheap: Botanist expert at the Department of Botany, Chulalongkorn University

Attendees - *Lalita Radtanajiravong, Varinporn Lerdpornchareon, Friday, 24 January 2013 at 8:00 AM*

What are the factors used in growing plants?

There are three important factors for growing plants:

- a. Soil: The suitable soil type for growing edible, organic plants is loam soil
- b. Water: The plot needs to always have source of water available and rubber hoses are used in order to water all regions of the plot. This is because organic plants have to be watered frequently, thus sufficient water sources in the allotted plot need to be identified.
- c. Sunlight: Sunlight area coverage during the day needs to be considered for choosing types of organic plants and assigning them in their most suitable areas. The directions of sunrise and sunset were observed. Sunlight during the day was observed and recorded for where the sunlight has spread- whether it was only on small part of the land or if it was all over the area.

Are there any other minor factors influence plant growth?

Other factors will affect the growth of plants are humidity, temperature, and season.

- a. Humidity: This factor can be fixed by the amount of water given to plants. If there is high humidity, plants will receive less water. If there is low humidity, plants will receive more water.
- b. Temperature: We will gather information about weekly temperatures of Pathumwan district from the Thai Meteorological Department.
- c. Season: The type of plants needs to be changed periodically in order to make it suitable for each season. Moreover, the shelf life of edible plants is short, making it even more important to change types of plants each season.

What is the fundamental method before the start of plant growth?

The land must be divided into two sections due to several reasons. When the plants start to grow, it will start to get crowded and each plant will snatch other plants' nutrients, causing the plant to not achieve a full growth cycle. First scattering seeds throughout the designated area without too much sunlight would be enough for young baby sprouts. Then the young plant should be moved to another plot after several weeks. To transfer the plant, avoid touching the root and move them carefully. Due to this reason, organic nursery plant beds are required apart from mature plant beds.

Referring to the first question, do the depth of soil affect growth in plants?

The depth of soil will not directly affect the growth of plants because the gardener can settle the depth of the soil. In general, soil depth should be around 4 inches or so. If it is lower, they can pile up the soil from surrounding areas to make it higher.

Does the growing plant in the shelves is suitable in our project?

Growing plants in shelves is not a suitable method for edible plants in our project because it has high expense and a complicated settlement. Edible plants should be directly in contact with the soil.

Do you have any interesting places where we could go to learn more about organic agriculture?

The garden on the roof at Lak Si district office, which is available everyday or the garden at Lad Phrao may be interesting places.

Is this list of edible plants suitable to be grown in Bangkok's weather conditions?

Some of them can be grown in Bangkok's weather conditions, however some of them are difficult to maintenance. Bird's eye chili, Holy Basil, Sweat basil, Kale, Pea aubergine, Chinese cabbage, Banana, Galangale, Lemon basil, Lemongrass and Goat peppers are suggested because it can be grown easily and these plants do not attract too many pests. This factor is important because organic agriculture requires plants to be grown without any pesticides.

Interview with Assist. Prof. Dr. Yongyuj Chunyarak: Botanist expert at the Department of Botany, Chulalongkorn University

Attendees - *Kunaporn Kittisopidadit, Thanida Dangprasert, Lalita Radtanajiravong*

Friday, 31 January 2013 at 8:00 AM

How should the plot of land be designed so that it is utilised most efficiently?

You should design the plot of land creatively but have the design correspond to each plant's needs. Consider their physical properties and environmental suitability carefully when locating each plant.

Do you agree with the list of plants that was suggested by Professor Kanogwan?

I do agree with the list of plants. However, this plot of land is suitable not only for vegetables but also herbs because the quality of the two main factors, soil and sunlight are sufficient. Herbal plant growth is easier in terms of maintenance and probability for survival.

Is 5 hours per day sufficient for growing these plants?

Yes, 5 hours are enough for plant growth.

Can you suggest any interesting herbs?

Andrographis paniculata and Aloe vera are two interesting herbs because these two herbs can be grown in any season. Also, the *Hop-headed Barleria* (Scientific Name: *Barleria Lupulina*) and *Venus flytrap* were suggested because they are colourful and they both have many uses. They can also be used as decorations in the garden.

Can you suggest interesting easily grown edible plants?

Interesting easily grown edible plants are Lemongrass, Sweet basil, Holy basil, Chilli because every part of them can be used.

Do you have any suggestions for our project?

For further suggestions, I recommend that the team should consider and research more in-depth about the spread of roots for each plant.

What is the soil classification for our soil sample?

This soil is called "loam soil", which can absorb lots of water and it also contains useful nutrients. Moreover, this soil type is very suitable for the growth of organic edible plants.

What should we concern about soil for organic plant growth?

Organic matter must not be added to the soil for at least three years and additional chemical fertilizers are strictly prohibited.

Interview with Miss Sakhorn Boonpeng: Wat Pathumwanaram School's gardener

Attendees - Kunaporn Kittisopidatit, Varinporn Lerdpornchareon, Kroerit Maneejark, Woo Jin Park, Thanida Dangprasert

Friday, 24 January 2013 at 8:00 AM

Has the school started with any developments in preparation for this project?

The school has begun development of the land by covering the ground with soil, 8 inches in soil depth. Moreover, the school has also acquired unwanted plants and mushroom fungi from existing learning programs available in the school as fertilizers for this plot.

Is this soil suitable for plant growth?

Yes, it is suitable for plant growth. I have successfully planted Lemongrass and Banana tree here using this soil. I was there when the soil was added and I knew that the soil has indeed not been tampered with chemically.

What other factors in this land would potentially be influential to plant growth? Can you give us any details?

For sunlight patterns, the sun rises on the Paragon Department Store side (the East) and sets on the opposite side (the West). Sunlight will spread on the land all day from 11:00 AM – 4:00 PM. Moreover, this area is not windy because tall buildings surround the school. These tall buildings block the wind.

Interview with Miss Pensri Tosa-ard: Lak Si district officer

Location: The Naturally Organic Gardening Learning Centre: Rooftop Agricultural

Attendees - *Kunaporn Kittisopidadit, Thanida Dangprasert, Lalita Radtanajiravong,*

Varinporn Lerdponchareon, Kroerit Maneejak, Woo Jin Park

Tuesday, 28 January 2013 at 9:00 AM

What is an important method required to grow plants successfully?

Young plants should be grown first in a nursery bed. These nursery beds should be covered as protection from harsh winds or direct sunlight. Then they can be moved to mature plant beds.

What is a nursery bed?

A nursery bed is a small piece of land, which is used for preparation of raising seedlings. Also, the role of nursery beds are to provide extra care needed for baby plants to ensure proper growth before they are planted in a permanent garden.

What are the benefits of having a nursery bed?

There are two benefits of having nursery beds. First, it decreases the time for the plant's growth cycle. Second, it results in healthier produce because plants can be cared for properly. If you directly grow plants in mature plant beds without nursery beds, the ones that receive more nutrients survive and grow into a full plant while others do not achieve a full growth cycle and die eventually.

Please describe the process of using nursery beds.

1. Sow seeds in nursery bed
2. Water seeds two times a day in the morning and evening for two days. Keep seedlings away from direct sunlight.
3. After two days, change the location of the nursery bed for plants to now receive direct sunlight. Leave the plants for seven days; however, use a net to avoid sunlight too intense, which may cause baby plants to shrivel and die.
4. Add urea and soybean hormones. The concentration should be half of the normal concentration. Add these two hormones every other day for 20 days in the plants' roots.

How should plant beds be prepared? What are the aspects of plant beds?

50-70 cm width between each plant bed is a proper distance for a walking area between beds. The suitable width for beds should be around 1.20 m for ease in taking care of plants in each bed and the bed's length depends on your plot's size. Moreover, one bed should grown many kinds of plant to avoid pests because each kind of pest eats different kinds of plants.

What is the concern when growing plants?

1. Plant diseases, to solve this problem, grow various types of plants in a garden because different plants have different diseases. If one type of plant caught a disease, the rest will still survive. This would leave certain plant crops alive for products.
2. Pests; also different plants attract different pests.
3. Lack of nutrients

What are the factors that affect plant growth?

1. Use climber plants, such as ground, bitter cucumbers to cover plant beds to avoid direct sunlight and storms.
2. Sunlight: Plants response to sunlight by facing the sun, causing it to grow longer facing the sunlight direction, which would make it weak.
3. Water: Store water (from the tap) in a proper container for two days to make the chlorine evaporate before using this water to water the plants.

How to make organic fertilizers by using chunks of dead mushrooms

1. Batter it into small pieces using a hoe
2. Add biological fermented water; this process produces CO₂ gas
3. Wait until CO₂ gas evaporates and the heat cools down
4. Fertilizer is ready when it is in room temperature
5. Use 1:3 of this fertilizer and soil ratio

Can you suggest interesting plants to grow?

These plants should change according to their suitable seasons.

Summer: Weather and season suitable for plants with strong and hard leaves

Winter: Weather and season suitable for plants with softer leaves

APPENDIX D: ENGLISH AND THAI EDUCATIONAL SYSTEM

English Educational System	Thai Educational System	Ages
Grade 1	Prathom-suksa 1	6-7
Grade 2	Prathom-suksa 2	7-8
Grade 3	Prathom-suksa 3	8-9
Grade 4	Prathom-suksa 4	9-10
Grade 5	Prathom-suksa 5	10-11
Grade 6	Prathom-suksa 6	11-12
Grade 7	Mathayom-suksa 1	12-13
Grade 8	Mathayom-suksa 2	13-14
Grade 9	Mathayom-suksa 3	14-15
Grade 10	Mathayom-suksa 4	15-16
Grade 11	Mathayom-suksa 5	17-18
Grade 12	Mathayom-suksa 6	18-19

APPENDIX E: MAP OF WAT PATHUMWANARAM SCHOOL



APPENDIX F: LIST OF FINAL APPROPRIATE ORGANIC PLANTS WITH PROPERTIES



Scientific name: *Capsicum Frutescens*

Common name: Bird's eye chili

Family name: SOLANACEAE

Known as: Prik Keenhoo

Plantation Characteristics:

- Size of plant: 30-120 cm
- Suitable growing season: All year

Properties:

- Fights sinus congestion
- Aids digestion
- Relieves migraine and muscle pain
- Good source of Vitamins A and E



Scientific name: *Ocimum tenuiflorum*

Common name: Holy Basil

Family name: LAMIACEAE

Known as: Graprao

Plantation Characteristics:

- Size of plant: 1-4 ft.
- Suitable growing season: Rainy

Properties:

- Healing powers for fever, common colds, coughs, sore throats and headaches



Scientific name: *Ocimum basilicum L.*

Common name: Sweet Basil

Family name: LABIATEAE

Known as: Ho-ra-par

Plantation Characteristics:

- Size of plant: 1-2 ft.
- Suitable growing season: Summer and winter

Properties:

- Relieves cramping pains and flatulence
- Cures skin irritations and headaches
- Repels insects



Scientific name: *Brassica alboglabra*

Common name: Kale

Family name: CRACITERAE

Known as: Ka-na

Plantation Characteristics:

- Size of plant: 33-35 cm
- Suitable growing season: All year

Properties:

- Used for detox smoothies as it has cleansing properties
- Helps protect against cataracts, cardiovascular health and boosts the immune system
- Anti-inflammatory



Scientific name: *Solanum Xanthocarpumschrad*

Common name: Pea Aubergine

Family name: SOLANACEAE

Known as: Ma-kour-pror

Plantation Characteristics:

- Size of plant: 2-4 ft.
- Suitable growing season: All year

Properties:

- Improves excretory system, blood circulatory system and digestive system
- Reduces symptoms of diabetes



Scientific name: *Ipomoea aquatica* forsk

Common name: Morning glory

Family name: CONVOLVULACEAE

Known as: Puk Boong

Plantation Characteristics:

- Size of plant: 30 cm.
- Suitable growing season: All year

Properties:

- Main resource of Vitamins A, C and calcium
- Maintains good eyesight



Scientific name: *Brassica chinensis* Jurl *Varparachinensis*

Common name: Chinese Cabbage

Family name: CRUCIFERAE

Known as: Kwang Toong

Plantation Characteristics:

- Size of plant: 45-55 cm.
- Suitable growing season: Rainy and summer

Properties:

- Cancer-preventing properties



Scientific name: *Musa sapientum L.*

Common name: Banana tree

Family name: MUSACEAE

Known as: Ton-Gluay

Plantation Characteristics:

- Size of plant: 3-5 m
- Suitable growing season: All year

Properties:

- Helps reduce the irritation of the digestive system
- Rich in Iron which promote hemoglobin production so your blood can clot faster in case of serious injury
- Reduces acidity in the stomach



Scientific name: *Zingiber officinale*

Common name: Ginger

Family name: ZINGIBERACEAE

Known as: King

Plantation Characteristics:

- Size of plant: 50 cm.
- Suitable growing season: All year

Properties:

- Prevents the symptoms of motion sickness
- Relieves vomiting while pregnancy
- Decreases dizziness and cold sweating



Scientific name: *Alpinia galangal* (L.) Willd.

Common name: Galingale

Family name: ZINGBERACEAE

Known as: Kar

Plantation Characteristics:

- Size of plant: 1.5-2.0 m.
- Suitable growing season: All year

Properties:

- Anti-inflammatory
- Treatment of arthritis and rheumatoid arthritis
- Relieves discomfort
- Alleviates motion sickness



Scientific name: *Ocimum americanum* L.

Common name: Lemon basil

Family name: Lamiaceae (Labiatae)

Known as: Mang luk

Plantation Characteristics:

- Size of plant: 2-3 ft.
- Suitable growing season: Rainy and summer

Properties:

- Helps decrease weight
- Heals headaches



Scientific name: *Cymbopogon citratus stapf.*

Common name: Lemon grass

Family name: POACEAE

Known as: Ta-krai

Plantation Characteristics:

- Size of plant: 4-6 ft.
- Suitable growing season: Winter

Properties:

- Headache and migraine relief



Scientific name: *Andrographis paniculata*

Common name: Kariyat

Family name: Acanthaceae

Known as: Fah Tah-Rai-Jone

Plantation Characteristics:

- Size of plant: 30-70 cm
- Suitable growing season: Winter

Properties:

- Heals respiratory infection
- Reduces the severity and duration of the flu



Scientific name: *Capsicum annuum* Linn. Var acuminatum Fingerh

Common name: Cayenne pepper

Family name: SOLANACEAE

Known as: Prik chee fah

Plantation Characteristics:

- Size of plant: 0.5-1 m
- Suitable growing season: All year

Properties:

- Capsaicin substance in chili's seed can heal flu
- Decreases cholesterol in blood vessel



Scientific name: *Aloe vera* (L.) Burm.f.

Common name: Aloe vera

Family name: XANTHORRHOEACEAE

Known as: Wan hang jora-ke

Plantation Characteristics:

- Size of plant: 60-100 cm.
- Suitable growing season: Winter

Properties:

- Preserves diabetes
- Heals headache
- Gel in Aloe vera can heal burn wounds

APPENDIX G: ORGANIC PLANTS HUNTER GAME EVALUATION FORM**Organic Plants Hunter Game Evaluation Form****Activity Coordinators:** *Kunaporn Kittisopidatit, Thanida Dangprasert, Lalita**Radtanajiravong, Varinporn Lerdpornchareon, Kroerit Maneejak, Woojin Park*

Location: Wat Pathumwanaram School

EVALUATOR:

Please make a ✓ in the box for your rating.

No.	Criteria	Rating				
		5	4	3	2	1
Staff						
1	Knowledge and ability of staff					
2	Personality of staff					
3	Preparation and punctuality					
4	Ability to manage students and fix any problems during the activity					
Contents						
5	Contents are interesting to the students					
6	Contents are suitable to the ability of students					
Activity						
7	Activity was useful for students to practice research and analysis					
8	Activity was created for students in terms of learning by doing					
9	Environment was suitable for the activity					
10	Activity was created to help improve students' abilities					
11	Students were active during the activity; the activity was enjoyable					
Teaching Materials						
12	Creativity of teaching materials					
13	Teaching materials are able to help students understand the content more clearly					

COMMENTS:.....

.....

.....

APPENDIX H: ORGANIC PLANTS HUNTER GAME

Total number of students = 33

Organic Plants Hunter Game Activity Materials



Feature board with plants' names and pictures

Game Preparations

1. Place plant pictures around the school.
2. Place ice cream wooden sticks representing each plant under those pictures.
3. Provide a brief introduction for organic agriculture.
4. Provide the activity's objectives to the students.

Organic Plants Hunter Game Instructions

1. Divide students into groups of 6; totaling 5 groups.
2. 3 plant names are given to each team.
3. 10 minutes will be given as the time limit for each team to match the picture of the plant with the plant's name. Properties of that plant will be available at the back of the picture.
4. After finding the picture of what they think is the correct plant, teams will be instructed to bring back an ice cream wooden stick—which represents each plant—to check with our staff if they have the correct answer.
5. If the team has the correct answer to the plant, they are required to memorise a property of that plant before gaining 1 point for their team.
6. The team with the highest points with the most correct answers will win the activity.
7. The staff will then conclude the game with providing the Expected Learning Outcomes and provide some more information to the students about organic agriculture.
8. Prizes will be awarded to the winning team and consolation prizes are given to the rest of the teams.

Expected Learning Outcomes

1. Teamwork
2. Plant names
3. Plant properties
4. Introductory knowledge to organic agriculture

APPENDIX I: THREE-DIMENSIONAL PROTOTYPE DESIGN IN VIRTUAL DESIGN DEVELOPMENTS



The prototype design development phase 1



The prototype design development phase 2



The prototype design development phase 3

