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SWAP
Sustainable solid WAste management and Policies

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Deliverable 4.6

REPORT ON IMPLEMENTATION AND FUNCTIONING OF TRAINING HUBS

Project Acronym	**SWAP**		
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HAMBURG UNIVERSITY OF TECHNOLOGY

January 2024

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DISCLAIMER

ABBREVIATIONS

3R	Reduce, Reuse, Recycle
EU	European Union
NGO	Non-Governmental Organisations
OOLMS	Open Online Learning Management System
PDCA	Plan Do Check Act
SME	Small- and Medium-Sized Enterprises
SWM	Solid Waste Management
SWOT	Strenghts – Weaknesses – Opportunities – Threats
THB	Thai Bath
TVET	Technical Vocational Education and Training
VET	Vocational Education and Training

INTRODUCTION

Project context

Project SWAP openly addresses capacity building of partners based in Cambodia, Thailand and Vietnam with regard to developing the Higher Education sector within society at large, by pursuing two main regional thematic priorities:

1. university-enterprise cooperation, entrepreneurship and employability of graduates; and
2. definition, implementation and monitoring of the reform policies.

Thanks to its multi-actor approach based on a quadruple-helix structure, SWAP aims at the improvement of knowledge, competences and skills in the field of solid waste management by:

- developing modern teaching and learning technologies and tools, including specific methods required to address the needs of specific target groups in Southeast Asia;
- providing governance models, to modernise, increase and sustain the quality of institutions in the Higher Education sector.

The first priority above is addressed either by developing educational products at different levels and by establishing regional "Training Hubs for Sustainable Solid Waste Management and Policies", physical places where training can occur, services can be delivered, and Academy, VET and the labour market can meet and cooperate, in a true multi-stakeholder environment, well beyond the project duration. Such spaces are intended to support the multi-stakeholder approach of the project: academy professors and researchers, VET trainers, students will access and exploit the OOLMS (Open Online learning Management System, that is, the learning platform of the project), while universities, training providers, local institutions, companies and associations will cooperate to physically start the Training Hubs and govern them, complementing technical contents with the topics of sustainability, occupational health, emission control, safety issues and business creation in the sector, overall increasing the know-how and skills of the graduates in the sector.

The training hubs

Training Hubs have been designed by conveying indications and experience coming from the EU partners (e.g. quality standards, management procedures, etc.) and needs/requirements driven by local contexts in Vietnam, Cambodia and Thailand. The design process follows a full PDCA approach, starting from the needs analysis embedded in previous project activities, and keeping into account quality standards the Hubs should fulfil. Partners started defining goals and indicators of success (e.g. number of training courses delivered vs. proposed, expected number of participants, etc.), followed by a first, overall identification of tasks, programmes, services to be delivered. In this phase, a number of strategic choices were made by the Asian partners, regarding e.g.:

- the scope of each hub;
- the structure, role and responsibilities of players participating in governance bodies;
- the resources required: human, premises, financial sustainability, etc.

Downstream this planning phase, partners went on further detailing their Hubs, like for example refining the number and type of programmes to be delivered, a forecast on the number of participants, and –most important– of funding sources.

In all countries, each University chose the leading domain for the corresponding Training Hub, based on own specialisation and skills and on the local, regional or national needs and development priorities, as follows:

Country	*University*	*Training Hub domain*
Thailand	CMU - Chiang Mai University	Plastic waste segregation and circular-based utilization
	MJU - Maejo University	Agricultural waste utilization
Vietnam	HUAF - Hue University of Agriculture and Forestry	Solid Waste Management
	TUAF - Thai Nguyen University of Agriculture and Forestry	Municipal Solid Waste Management
Cambodia	RUA – Royal University of Agriculture	Municipal Solid Waste Management
	UHST – University of Heng Samrin Thbongkhmum	Waste management through segregation and recycling

Training hubs started their activities between March and November 2023, and had the chance to start piloting their functioning for 3 to 9 months so far, a sufficient time to start assessing their performance, pros and cons. Of course, most of the training hubs activities are to be started after the end of SWAP, and current achievements can only be considered as initial ones.

About this report

This report stands as a tool for reviewing performance and "closing" the PDCA circle, paving the way for future re-planning. It has been drafted by many hands, that is, by Training Hubs governance teams and by EU partner experts. Findings have been shared and discussed, to ensure cross co-operation among different national and international governance teams.

After the ***introduction***, this document presents the ***six individual reports*** from each Training Hub. They all follow the same structure, in favour of comparability, consisting in:

- general data about the hub
- description
- activities carried out so far
- assessment of results so far, including an outlook on the future
- appendixes

The six reports are shortly commented by summing up main results, common key findings, and through a ***SWOT analysis***, aimed at pointing out the main strong points, possible room for improvement, and to provide hints for sustainability.

A final chapter matches elements from the SWOT analysis and draws ***conclusions***, including a few recommendations for the future.

The structure of this document was agreed among partners, in such a way to remain as a kind of "guidelines" for possible future reports in the next years, after the end of SWAP, with a view to start a good practice in regular monitoring and reviewing.

This document is in English. Individual reports are also available in each hub's national language, as attached separate files.

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SWAP
Sustainable solid WAste management and Policies

Report from Chiang Mai University (CMU)

Thailand

Main Author: Sulak Sumitsawan

Topic of the Training Hub	Plastic waste segregation and circular-based utilization
Physical address	Department of Environmental Engineering Chiang Mai University 239 Huay Kaew Rd Suthep Mueang Chiang Mai District Chiang Mai 50200 Thailand
Inauguration date	May 25th, 2023

INTRODUCTION

As reported in the document "D4.4 Training Hub Feasibility Study", also a deliverable of project SWAP, CMU has established a training hub that offers services on capacity building and counseling about solid waste management, i.e., plastic waste. The training hub was at the Department of Environmental Engineering, Faculty of Engineering, Chiang Mai University. The commencement of the training hub was May 25, 2023.

The reason for selecting plastic waste as the offered topic of the training hub is the significance of the plastic waste problem on a global and regional scale. In 2018, global plastics production reached 360 million tonnes. Plastics are commonly used in various industries, including packaging, consumer goods, electronics, automotive and aviation manufacturing, textiles, and agriculture. Thailand's petrochemical sector is the largest in the Southeast Asian region and 16th in the world. In 2018, Thailand produced 11.8 million tonnes of downstream petrochemical products, including plastic resins. Thailand's plastics industry contributed 1,100 billion baht (USD 36.9 billion) to the national economy in 2018, representing 6.71% of Thailand's GDP (World Bank Group, 2021). Mismanagement of plastic waste leads to plastic waste appearing in the ocean that, creates marine ecosystem problems, open burning of plastic waste which emits air pollutants and greenhouse gases, clogging the urban drainage system, which is a cause of flooding, etc. Plastic waste generation has increased more rapidly than any other waste stream, negating recent improvements in the proper disposal of plastic waste. Plastic waste has increased at an average rate of 12% per year to between 2 and 2.5 million tonnes of plastic waste annually, making Thailand among Asia's most prominent plastic consumers (Ocean Conservancy, 2017; PCD, 2019). Thailand's plastic packaging waste comes mainly from two products: plastic bags and bottles. Together, they account for approximately 60% of all plastic packaging waste. In terms of mass, plastic bag waste (including mono-layers and shopping bags) is almost double that of plastic bottle waste; very few bags are collected for recycling – they are lightweight and often too contaminated for recycling. However, household waste separation can significantly increase the efficacy of recycling plastic bags (WWF THAILAND, 2020).

The manufacturer of plastic and packaging industries currently works with linear (take, make, dispose), single-use product design. Multiple layers, dyes, lightweight, single-serving products, and other design choices reduce the feasibility of collection and recycling. This situation accelerates the amount of plastic waste disposal and limits opportunities to reintroduce plastic back into production processes where it can be reused to make new products. In addition, current recycling procedures produce downcycling (where materials are downgraded to a lower value or a lower level of functionality). Furthermore, the low prices for certain types of plastic and increasing plastic waste imports have impacted Thai recycling companies without a large end-market for their recycled materials, further inhibiting investment in recycling businesses (Johnson and Trang, 2019; WWF THAILAND, 2020).

Using plastic waste based on the circular economy principle (i.e., upcycling to the higher value products) could increase the value of plastic waste and boost the incentive of plastic waste collection and circular utilization. As a result, it can reduce waste to landfill and mismanaged plastic waste that causes plastic leakage into the ocean and helps the Thai government to meet the target in plastic waste management. However, this issue is relatively new to Thailand, and there is still a significant knowledge gap, and there are very few training centers on this issue. Therefore, the training hub on "Plastic waste segregation and circular-based utilization" has been established. This hub will be in the attention of the Thai government and private sectors concerning their EPR to support this activity or support the trainee to set up community enterprises all around Thailand to create jobs and income for the community and reduce mismanaged plastic waste at the same time.

The training on "Plastic Waste Segregation and Circular-based Utilization" has been offered as a 2-day course comprising lectures and hands-on workshops at the CMU. The target groups are school students and teachers, community members, and government and private company employees who work related to solid waste management.

GOALS

The primary goal of the training hub is to increase awareness of the plastic waste problem at the current time and the options to earn revenue from plastic waste in various ways depending on the contexts of the communities. The contents of the courses we deliver will develop and strengthen the skills and abilities of communities and organizations around northern Thailand to segregate and increase the value of plastic waste by upcycling. The income from selling upcycled plastic products will incentivize communities to keep plastic products in the circle and ultimately reduce the amount of plastic waste in landfills or environments.

The goals and objectives of the training hub are specified as follows.

Goal #1—Trainees can correctly segregate plastic waste and convert waste into valuable products.

Objective 1.1: Improve knowledge in understanding plastic waste type, the importance of plastic waste segregation, and how to segregate waste correctly.

Objective 1.2: Improve knowledge in identifying the quality of plastic suitable for upcycling and how to do plastic waste pre-treatment/ preparation for upcycling.

Objective 1.3: Provide hands-on experience on plastic waste conversion into valuable products.

Goal #2—Trainees have a good mindset about converting waste to valuable products and have some view on business opportunities for developing products from waste.

STRUCTURE

The CMU training hub is operated under the Department of Environmental Engineering, Faculty of Engineering, Chiang Mai University. The structure of the training hub is shown in Figure 1.

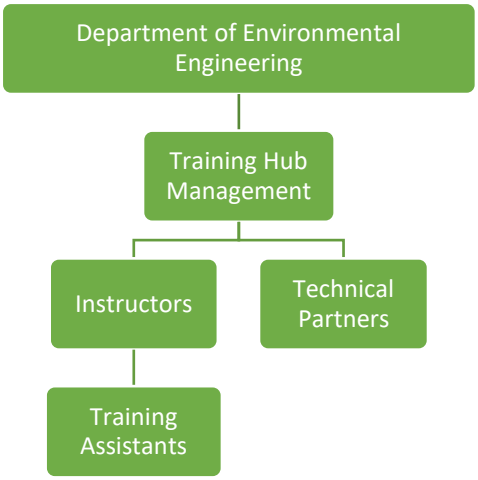

Figure 1. Structure of CMU Training Hub

The policies and direction of the training hub are directed by the management of the training hub. The representative of the training hub is the Head of the Department of Environmental Engineering, Assistant Professor Dr. Patiroop Pholchan. The management members are SWAP team members, who are the faculty at the department. The management is responsible for the offered subject, training program, course schedule, public communications, and financials. The provided subject will be evaluated by training hub management on the needs and policies of the CMU and Thailand and the availability of the resources.

The instructors are the faculty member at the Department of Environmental Engineering. The instructors are assigned to teach the program based on the course's subject and the faculty's expertise. The instructors are responsible for managing the course, giving lectures and evaluations on the program. The instructors also work in the hands-on workshop to allow them to practice and apply their knowledge from the classroom to segregate, transform plastic waste into fresh filament, and upcycle them to make new products. During the classroom lectures and workshops, training assistants help the instructors by teaching some subjects based on their experiences or graduate degree research.

Technical partners provide technical support for the machines and equipment used in the training hub. They could give the technical details and appropriate techniques to speed up or increase the productivity of the machine and equipment.

The current structure of the CMU training hub is as follows:

Management representative:	Assistant Prof. Dr. Patiroop Pholchan (Head of the Department)
Instructors:	Associate Prof. Dr. Napat Jakrawatana (Lead trainer)
	Dr. Sarunnoud Phuphisith (Trainer)
Assistant trainers:	1 PhD and 2 Master students
Partners:	Experts from company Zero Waste YOLO Co., Ltd.
Facilities:	A training room, computer, and screen (belonging to Dept. of Environmental Engineering). The plastic shredder, extruder, and 3D printer obtained using the equipment budget of SWAP will be used during the training.

ACTIVITIES

Training structure

The CMU training hub operated so far basically for the delivery of a pilot training course on “Plastic Waste Segregation and Circular-based Utilization”.

The course contents are:

- Types of plastic packaging
- Production and the global problem of plastic waste
- Plastic waste problem in Thailand
- Guidelines for managing plastic waste according to the circular economy.
- How to separate plastic waste
- Plastic waste processing to increase value and do business for the environment.
- Hands-on training

The course delivers two days of activities, including lectures on the basics of plastic waste and practices on plastic segregation and upcycling in the workshop. Day one laid background on plastic types, problems of plastic waste, segregation of plastic waste, and plastic waste upcycling. These topics were delivered in the class at the Department of Environmental Engineering.
Day two was the workshop where participants worked with the actual plastic waste, the plastic shredder, filament extrusions, and 3D printing. The schedule is shown in Table 1.

The training materials include the PowerPoint presentations for each session, also available on the project platform. The assistant instructors uploaded all the materials to a specific Google Drive folder. The link to the folder was provided at the beginning of the course and was available at all times during the training. The files were in PDF format, which the participants could easily access from their mobile devices.

Table 1. Training Schedule

Day 1: Lecture
Location: Classroom, Department of Environmental Engineering

Time	***Program***
09.00 – 09.20	Course Opening
09.20 - 10.10	Background of plastic and plastic waste - Types of plastic packaging - Production and the global problem of plastic waste
10.10 - 10.30	Break
10.30 - 12.00	Plastic waste situation Plastic waste problem in Thailand
12.00 - 13.00	Lunch Break
13.00 - 14.00	Plastic waste management Guidelines for managing plastic waste according to the circular economy
14.00 - 15.00	Plastic waste management How to separate plastic waste
15.00 – 16.00	Plastic waste upcycling Plastic waste processing to increase value and do business for the environment

Day 2: Workshop
Location: Environmental Engineering Laboratory, Department of Environmental Engineering

Time	***Program***
09.00-10.00	Practices on plastic waste segregation
10.00-12.00	Preparation of plastic waste for upcycling
12.00-13.00	Lunch Break
13.00-15.00	Plastic waste upcycling - Plastic filament extrusion - Filament moulding

Participant statistics
The target participants of the CMU training hub are school teachers and students, small to medium-sized communities interested in gaining some revenues from solid waste, and local municipalities and governments responsible for solid waste management.
Eleven participants attended the first edition of the training. The participants can be classified, as shown in Figure 2.

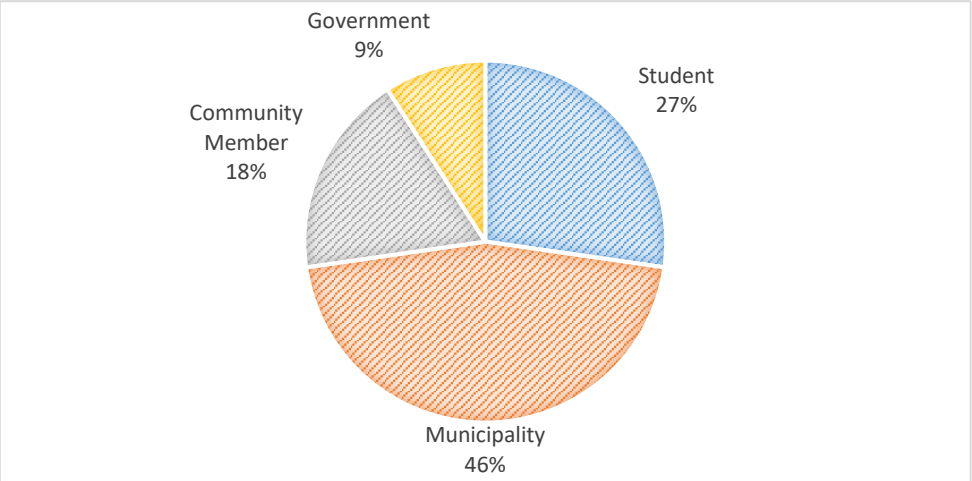

Figure 2. Percent by groups of the participants attending the first training.

Among the participants, 70% of attendees had jobs related to solid waste, and the other 30% did not work or had activities related to solid waste management. The attendees who did not work related to solid waste would be the students and community members interested in plastic waste segregation and upcycling. This batch was a good mix of participants; they could also learn from the experience of other participants who had experience in solid waste management. However, among these two groups, all participants paid attention to the classes and workshops well.

Assessment and Feedback

The participants were subjected to pre and post-tests to evaluate their background knowledge of plastic waste and their improvements after taking the course. The questions in the Pre- and Post-Tests were the same; the correct answers were not provided after the Pre-Test. The questions covered the basics of plastic material, types of plastic, recyclable plastics, and saleable plastics. Both tests were conducted by answering the questions which were uploaded to Google Drive.

a. Pre-Test Results

The average score of the participants in the Pre-Test was 4.5 out of 10. The highest score was eight, and the lowest was two. The question that participants could answer the most was the type of plastic that could be recycled, and 81% of the participants could answer the question. The least correct question was about the percentage of recycled plastic in Thailand, which the participants anticipated was higher than the actual; only 1 out of 11 participants got the correct answer.

b. Post-Test Results

After taking the course, the average Post-Test score was 7.5 out of 10. Two participants got all correct answers, while the lowest score was increased to 5. All participants could identify the plastic waste that could and could not be sold to the recycling buyer. They had better knowledge of the properties of plastic that made it possible to be recycled.

The Pre- and Post-test results indicated that the participants had improved their knowledge about plastic waste. They also realized that plastic waste differs; some are valuable and could make income. They also had opportunities to practice plastic waste segregation by separating plastic waste from the mix.

After completing the training, all participants were asked to evaluate the course they just finished. The questions were uploaded on Google Drive; the participants completed the evaluation anonymously. The assessment included three subjects which are:

a) Training course: duration, location and facility, delivery methods and course materials
b) Instructors: clarity of explanation, language, answering question

c) Training contents: applicability, confidence in applying knowledge, ability to explain to others
d) Suggestions

Each question is graded by a score of 1 to 5, where 1 was the least and 5 was the most.
The summary of the evaluations could be expressed as shown in Figure 3.

Figure 3. Levels of satisfaction with the training course.

Overall, the participants were satisfied with the training, instructors, and the contents provided in the course. They were confident that they could separate plastic waste by its type correctly and could be able to explain this knowledge to their colleagues at their workplaces or families. There were suggestions for subjects the participants would be interested in after this course. These topics include making packages from yard waste, food waste, electronic waste, and composting. These suggestions would be included in consideration for the offering topic in the future.

LOOKING AHEAD

The plastic waste problem is significant in global, regional, and local areas. This waste creates problems for urban infrastructures, human health, animals, and the environment. The disposal and degradation of plastic waste takes longer than anticipated, and the effects of plastic waste in the environment are still not fully known. A sustainable option to handle plastic waste is to keep the material in the circle of utilization as long as possible to minimize the disposal of plastic waste to either landfills or the environment.

The training on “Plastic Waste Segregation and Circular-based Utilization” would match the needs of the communities, local municipalities, schools, and governments because these target groups are already familiar with and realized the problem of plastic waste. The training will provide an opportunity for the participant to understand the options that they have depending on their situations. The upcycling of plastic waste will create new products that could make income for the organizations and reduce the amount of plastic waste in their communities simultaneously. Thus, this topic of the training hub could quickly get attention from the target groups.

Solid waste management, especially plastic waste, is CMU and Thailand's main agenda. Thus, this topic would get attention from the CMU, organizations, and private sectors for funding to

support the training hub. The cost of the training could also be kept low since the instructors are the faculty at the Department of Environmental Engineering. The raw material for upcycling processes could be obtained from general waste bins. The training facility is at the university with all the required resources. The expense that the training hub could face includes the maintenance costs of the filament extrusion and the 3-D printing, which should be included in the budget of the training hub.

Financial projections over 5 years

The expenses of the first training are shown in Table 2.

Table 2. Costs of a 2-day training course (May 2023)

Item	***Total Amount (THB)/(Euro)***	***Amount per capita (THB/Euro)***
Plastic Moulds and Waste Containers	1,231 / (31.8)	
Meals and Water	4,144 / (107.2)	450 / (12.0)
Maintenance (Labour)	600 / (15.5)	
Certificates	450 / (11.6)	41 / (1.10)
Training materials (gloves, name tags, straps, saw)	3,807 / (98.5)	
Total	**10,232 / (265)**	**491 / (13.10)**

The expenses in Table 2 show that the total cost for 11 participants during 2-day activities was 10,232 THB or 265 Euro. The costs of plastic moulds and containers, and training materials would not occur at every training since they could be reused in the following activities. The running costs are meals/water, and certificates of 4,800 THB or 124 Euro. This would be approx. 450 THB or 12 Euro per participant attending a 2-day course. The expenses not shown in the table include routine maintenance of the extrusion and printing machine. The maintenance was not due during this period since they are still considerably new, but the maintenance cost should be included in future expenses.

Based on the CMU training hub plan, there will be two training courses per year, with anticipated participants being 15 per course. The financial projection of the CMU training hub is shown in Table 3.

Table 3. Financial projection of CMU training hub (5 years)

Income	**2023 (Year 1)**	**2024 (Year 2)**	**2025 (Year 3)**	**2026 (Year 4)**	**2027 (Year 5)**	**Total**
Funding from University	20,000	20,000	20,000	20,000	20,000	100,000
Sponsorship from Private Companies	5,000	5,000	5,000	5,000	5,000	25,000
Registration Fee (200 THB / person)	6,000	6,000	6,000	6,000	6,000	30,000
TOTAL INCOME	31,000	31,000	31,000	31,000	31,000	155,000

all values in THB

Expenditure	2023 (Year 1)	2024 (Year 2)	2025 (Year 3)	2026 (Year 4)	2027 (Year 5)	Total
Materials and supplies	5,000	5,000	5,000	5,000	5,000	25,000
Meals	13,500	13,500	13,500	13,500	13,500	67,500
Repairs and maintenance	5,000	5,500	6,050	6,655	7,321	30,526
Wages (less emp. credits)	3,600	3,600	3,600	3,600	3,600	18,000
TOTAL EXPEND.	27,100	27,600	28,150	28,755	29,421	141,026

all values in THB

The 5-year financial projection shows that the training hub could maintain its activities on the assumption of 2 courses annually. The primary income is the support from CMU of 20,000 THB per year, which is relatively reasonable since this activity aligns very well with the university's mission to promote waste utilization. There will be no cost on the instructors because they are the faculty at the Department of Environmental Engineering. The participants would pay for the registration of 200 THB for the training which is relatively low, to ease the decision to attend the training.

The expenses of the training hub will be primarily the meals for participants. Repairs and maintenance for the equipment would increase by 10% yearly. The assistant instructor will receive a wage of 300 THB per day for 2 days, and they will help organize and prepare the materials, equipment, and meals ready for the training. This will lift a burden on the instructors significantly.

The financial projection indicates that the training hub would run smoothly under this scenario. However, should any unplanned financial situation arise, the meals could be excluded from the expenses, and the cost of running will be much lower, which could neutralize the balances.

APPENDIX

We report here some pictures and material of the inauguration day and from the course delivery.

Figure A1. First Training Flyer

Figure A2. Training of basic on plastic waste

Figure A3. Participants worked on plastic waste segregation and upcycling

Figure A3. Plastic bottle caps and their upcycling products

Figure A4. Machine and equipment for plastic waste upcycling

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SWAP
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Report from Maejo University (MJU)

Thailand

Main Author: Mujalin Phochan

Topic of the Training Hub	Agricultural waste utilization
Physical address	Faculty of Science Maejo University No. 63 Moo 4, Nong Han Subdistrict San Sai District Chiang Mai Province 50290 Thailand
Inauguration date	March 10, 2023

INTRODUCTION

As reported in the document “D4.4 Training Hub Feasibility Study”, also a deliverable of project SWAP, MJU has established a training hub on agricultural waste utilization that offers services on capacity building and counseling about solid waste management for agricultural community. The Thai agricultural sector encompasses approximately 24 million individuals, accounting for 149.24 million hectares of agricultural land, which constitutes nearly half of the nation's agricultural output. Thai farmers tend to experience relatively modest average incomes, impacted by global market conditions, climate variations, and fluctuations in raw materials and product prices. Furthermore, post-harvesting, a substantial volume of agricultural waste remains unused, a concern that is expected to grow with increased farm product demand. These waste materials are often disposed of without proper treatment, leading to environmental, health, and economic issues. Traditionally, only biomass with high heating value is considered for industrial biomass energy. However, contemporary interest is rising in the conversion of agricultural waste into value-added products, driven by the increasing demand for natural additives in products and stricter environmental regulations. Additionally, valorizing agricultural waste has the potential to enhance the well-being of local communities by generating extra income.

In recent years, there has been significant exploration into the potential uses of agro-residues in various industries, including chemicals, agriculture, food processing, and pharmaceuticals. This has led to intensive research into bio-products and their components. However, while value-added products derived from agricultural waste are already in use within the agro-processing industry, they have not yet become commonplace for local communities or small and medium-sized enterprises (SMEs). There exists a substantial divide between these two sectors. To bridge this gap and align with Thailand's sustainable development goals (SDGs), it is essential to establish a development framework and practical guidelines for Thai farmers to transform agro-residues into high-value assets for industrial agriculture. Nonetheless, the transition to a circular economy within agricultural communities remains a significant challenge.

Key trends such as green growth (the production of environmentally friendly products), health and wellness, preparations for an aging society, and food security have become increasingly prominent. Our training hub is well-positioned to meet these emerging needs through a series of training programs. The valorization of agricultural waste presents numerous opportunities across economic, environmental, and social dimensions, making it a promising avenue for exploration.

However, it is crucial to secure social acceptance, particularly from local stakeholders, in order to effectively carry out waste utilization initiatives. To achieve this, the training hub will engage relevant parties in the decision-making process when choosing a sequence of training hubs. This approach aims to mitigate potential conflicts, foster consensus among stakeholders, and enhance the success rate of both training and implementation. Ultimately, this collaborative effort will empower local farmers and SMEs to prosper through enhanced utilization and product development from agricultural waste.

The training on “Agricultural waste utilization" is offered as a 1-day course per programme, comprising lectures and hands-on workshops at Maejo university. The target groups are Farmers, SMEs entrepreneurs, communities, municipalities, and government and private company employees who work related to solid waste management. The MJU training hub inauguration took place from March 10th to March 12th, 2023, within the training facilities located in the Faculty of Science at Maejo University, specifically in the areas dedicated to environmental technology and biotechnology. They were 3 hands-on workshops of Agricultural

waste for soil amendment products: 1 day for composting and 1 day for biochar production and the last day for agricultural waste for health and wellness products: bakery from waste.

GOALS

The increasing demand for products containing natural additives and the implementation of more stringent environmental regulations have generated significant interest in the conversion of agricultural waste into value-added goods. Additionally, the process of valorizing agricultural waste holds the potential to enhance the well-being of local communities by generating additional income. Hence, the principal objective of MJU training hub is to address environmental concerns related to the management of agricultural waste, with a concurrent emphasis on promoting sustainability for the community. The course content is designed to enhance and fortify the capabilities and competencies of local communities, farmers, small and medium-sized enterprises (SMEs), local authorities, and university alumni in the creation of value-added products from agricultural waste. The income from products will incentivize communities to stop open burning of agricultural waste and drive circular economy in the agricultural sector. Here are objectives of MJU training hub:

- to convert agricultural waste into value added products
- to transfer knowledge and technology innovation combines local wisdom to develop high standards of agricultural products
- to develop community enterprise and entrepreneurship

To attain the previously mentioned objectives, we engage in the subsequent undertakings:

1. Hands-on training workshop/activities - Hosting 1-2 training sessions annually, catering to farmers, SMEs entrepreneurs, communities, graduate, alumni and municipalities in establishing their entrepreneurial ventures.
2. Seminar series - Conducting a series of seminars through MS Teams, Zoom, Massive Open Online Courses (MOOCs), or an online platform to provide upskilling and reskilling opportunities for alumni, farmers, SME entrepreneurs, communities, and local municipalities.

Our target group is made mainly by farmers, SMEs entrepreneurs, communities, municipalities.

STRUCTURE

The MJU training hub is operated under the program in environmental technology and biotechnology, Faculty of Science, Maejo university. The training hubs are organized on-site at the Hub's physical location at the MJU-SWAP training room, main lab hall at Faculty of Science and MJU solid waste management learning and training center at Maejo university (figure 1-3) and local communities.

TDuring the pilot phase, two scenarios for the management of MJU training hub were structured and tested, as shown in figure 4.

Scenario A: The management of the training hub is led by vice president of Maejo university, Assistant Professor Dr. Nuttawut Dusanee, who is responsible for setting the policies and direction of the hub. The management team is led by the head of faculty of science, who is setting the program, public communications, and financial matters. The instructors consist of SWAP team members, are the staff within the environmental technology and biotechnology program and other related field from Maejo university. They are responsible for various aspects such as the offered subjects, training programs, course schedules. The selection of subjects offered is

assessed by the training hub management, considering the needs and policies of MJU, community and Thailand, as well as the availability of resources.

Figure 1. Environmental laboratory

Figure 2. Biotechnology laboratory

Figure 3. MJU solid waste management learning and training centre

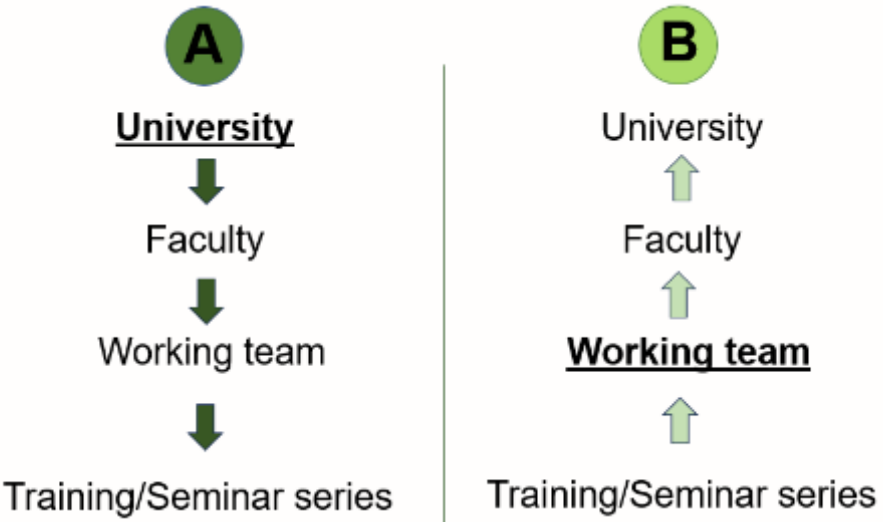

Figure 4. Training hub structure

Scenario B: The management of the training hub led by Head of SWAP program and head of the program in environmental technology, Assistant Professor Dr. Mujalin Pholchan, who is responsible for setting the policies and direction of the hub. The management team as well as instructors consist of SWAP team members, are the staff within the environmental technology and biotechnology program and other related field from Maejo university. They are responsible for various aspects such as the offered subjects, training programs, course schedules, public communications, and financial matters. The selection of subjects offered is assessed by the training hub management, considering the needs and policies of MJU and Thailand, as well as the availability of resources.

The structure of the MJU training hub can therefore be summarized as follows:

Main responsible organization:	– Program in Environmental technology, Faculty of Science, Maejo University – Program in Biotechnology, Faculty of Science, Maejo University
Management:	Asst.Prof.Dr.Mujalin Pholchan (Head of Program)
Facilities:	– Environmental technology laboratory, Faculty of Science, Maejo University – Hub's physical location at Biotechnology laboratory, Faculty of Science, Maejo University – Local community

ACTIVITIES

Training structure

The MJU training hub offers currently 5 sets of "products":

Set I: **Hands-on workshop** Agricultural waste for soil amendment products	**Title:** composting **Trainer:** Asst.Prof.Dr. Tapana Cheunbarn
	Title: biofertilizers **Trainer:** Asst.Prof.Dr. Tapana Cheunbarn
	Title: biochar production and application **Trainer:** Asst.Prof.Dr. Mujalin Pholchan
Set 2: **Hands-on workshop** Agricultural waste for functional food products	**Title**: Functional food **Trainer:** Dr. Tippapha Pisithkul : Asst.Prof.Dr. Piyanuch Niamsup : Asst.Prof.Dr. Pairote Wongputtisin
Set 3: **Hands-on workshop** Agricultural waste for health and wellness products	**Title:** Healthy product **Trainer:** Asst.Prof Dr. Mathurot Chaiharn
Set 4: **Hands-on workshop** Agricultural waste for bio-packaging	**Title:** Eco packaging **Trainer:** Asst.Prof.Dr. Mujalin Pholchan Asst.Prof.Dr. Rawadi Wongmaneerung Asst.Prof.Dr. Supattra Wongsanmai
Set 5: **Hands-on workshop** Agricultural waste for animal food	**Title:** Animal food **Trainer:** Asst.Prof.Dr. Mujalin Pholchan Dr. Wong Phan Promwong





Delivery methods

The above products were piloted through dedicated seminars and workshops. In particular, at the inauguration stage, a training course titled ""Agricultural waste utilization" was delivered, spanning over three days for 3 workshop series and featuring a variety of activities. These activities encompassed informative lectures on agriculture waste and its properties, fundamental of waste utilization technology, product quality and measurement as well as hands-on experiences in composting, biochar production and plant-based bakery conducted in a workshop setting. Every day of each series, participants were introduced to essential concepts regarding the composting and its standard, biochar and its application, plant-based products, techniques for agricultural waste utilization and the creation of value-added products, as well as online marketing and business models. These informative sessions took place within the lecture room the faculty of science.

In the afternoon sessions, the training courses were dedicated to practical workshops, during which participants engaged with actual composting, biochar production and plant-based bakery. They had the opportunity to prepare the stock culture, composting pile, biochar and soil quality measurement and baking brownie from agricultural waste. The complete schedule of the training course is shown in Table 1. For reference and further study, all training materials, including PowerPoint presentations for each session, were made readily available. These resources were uploaded by assistant instructors to a designated google drive folder. The link to this folder was shared with participants at the outset of the course and remained accessible throughout the training. Notably, these materials were provided in PDF format, ensuring ease of access for participants using mobile devices.

Table 2. Pilot Training Schedule

Day 1: 10th March 2023 :
Lecture series 1: Composting and liquid fertilizer
Location: Lecture room, Faculty of Science and composting site, Maejo university

Time	Program
08.30 – 09.00	Registration
09.00 – 10.00	Fundamental knowledge of composting and its standard
10.00 – 12.00	Composting from agricultural waste
10.30 – 10.45	Coffee break
10.45 – 12.00	Composting Technology
12.00 – 13.00	Lunch
13.00 – 14.30	Workshop on composting
14.30 – 15.00	Coffee break
15.00 – 16.00	Workshop on culture stock preparation for liquid fertilizer

Day 2: 11th March 2023
Lecture series 2: Biochar production and application
Location: Lecture room, Faculty of Science and MJU Training hub, Maejo university

Time	Program
09.00 – 10.30	Fundamental knowledge of agricultural waste and biochar
10.30 – 10.45	Coffee break
10.45 – 12.00	Physical properties of Biochar and SEM analysis
12.00 – 1 3.00	Lunch
13.00 – 14.30	Workshop on biochar production
14.30 – 15.00	Coffee break
15.00 – 16.00	Workshop on biochar application and its properties

Day 3: 12th March 2023
Lecture series 3: Waste to food product
Location: Lecture room, Faculty of Science and MJU Training hub, Maejo university

Time	Program
09.00 – 10.00	Background of Sacha inchi and its properties
10.00 – 10.15	Coffee break
10.15 – 11.00	Background of Plant-based bakery
11.00 – 12.00	Background of online marketing
12.00 – 13.00	Lunch
13.00 – 14.30	Workshop on Brownie from Sacha inchi peels
14.30 – 15.00	Coffee break
15.00 – 16.00	Workshop on Brownie from Sacha inchi peels

Participant statistics

The target participants of the MJU training hub include Farmers, SMEs entrepreneurs, communities, local municipalities in gaining some knowledge, technology to transform agricultural waste into value-added products and generate revenues from solid waste. The "Agricultural waste Utilization" training was inaugurated on 10th – 12th March 2023 with a total of 33 participants attended the first batch of the training. The participants could be classified, as shown in Figure 5.

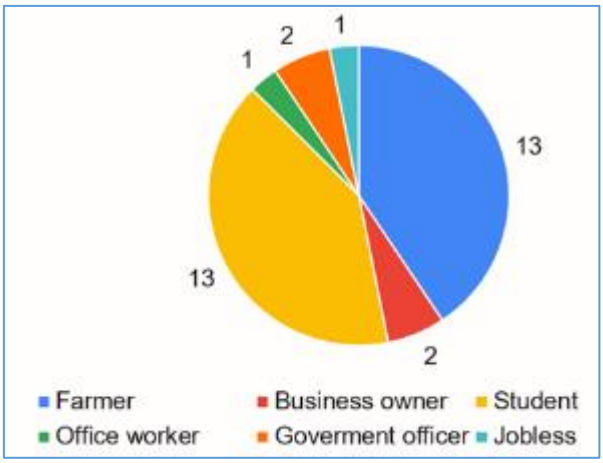

Figure 5. The percentage of participants attending the first training, grouped by categories.

Among the participants, 56% were employed in roles associated with agricultural waste management, while the remaining 44% were graduate students seeking employment opportunities or entrepreneurship. This group shared an interest in acquiring new skills for waste management. This diverse mix of attendees offered the advantage of enabling cross-learning, with those experienced in solid waste management sharing insights with those new to the field. It is noteworthy that both groups, despite their backgrounds, actively engaged and participated attentively in the classes and workshops.

Assessment and feedback

Monitoring is a process that routinely collects meaningful information to track the progress of a project by comparing collected data to pre-defined plans. MJU training hub on the topic of Agricultural waste utilization is organized in Chiang Mai. The overall goal of the training is to transfer knowledge and hands-on technology of agricultural waste utilization to valorization of the value-added products. To ensure that the success of the training hub goal, monitoring and evaluation process will be used as a tool. This process will help identify project direction, adapt implementation plans, and support decision-making in project management. The process of monitoring and evaluation process will be conducted regularly along with the operation of the training hub by MJU SWAP team members. The monitoring and evaluation results is reported to MJU SWAP management team, SWAP committees as well as MJU executives, and funders.

Several types of questionnaires including Expectations questionnaires, Participants' satisfaction questionnaire and Trainers' satisfaction questionnaire are used to identify the training needs, to monitor the results of the training program and to collect data on participants perception of the training and to collect data on the training course from the expert perspective. Also, the preliminary financial sheet is used to identify the foreseen resources and costs needed for the training and the financial form is used to enable the proper financial monitoring during the training program. Moreover, in order to propose and justify modification and communicate the achieved objectives and results of the training programmed, a monitoring report and a final evaluation report are developed.

Figure 6 shows the composition of the participant group.

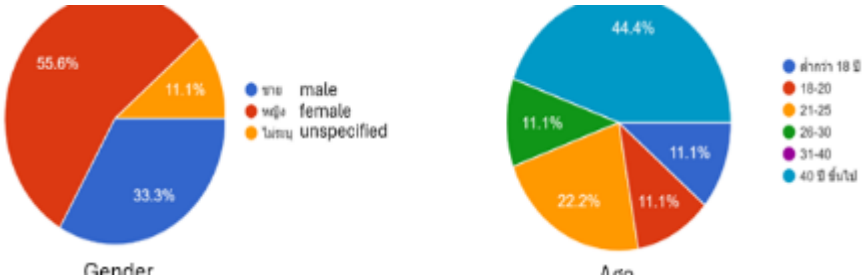

Figure 6. The participants.

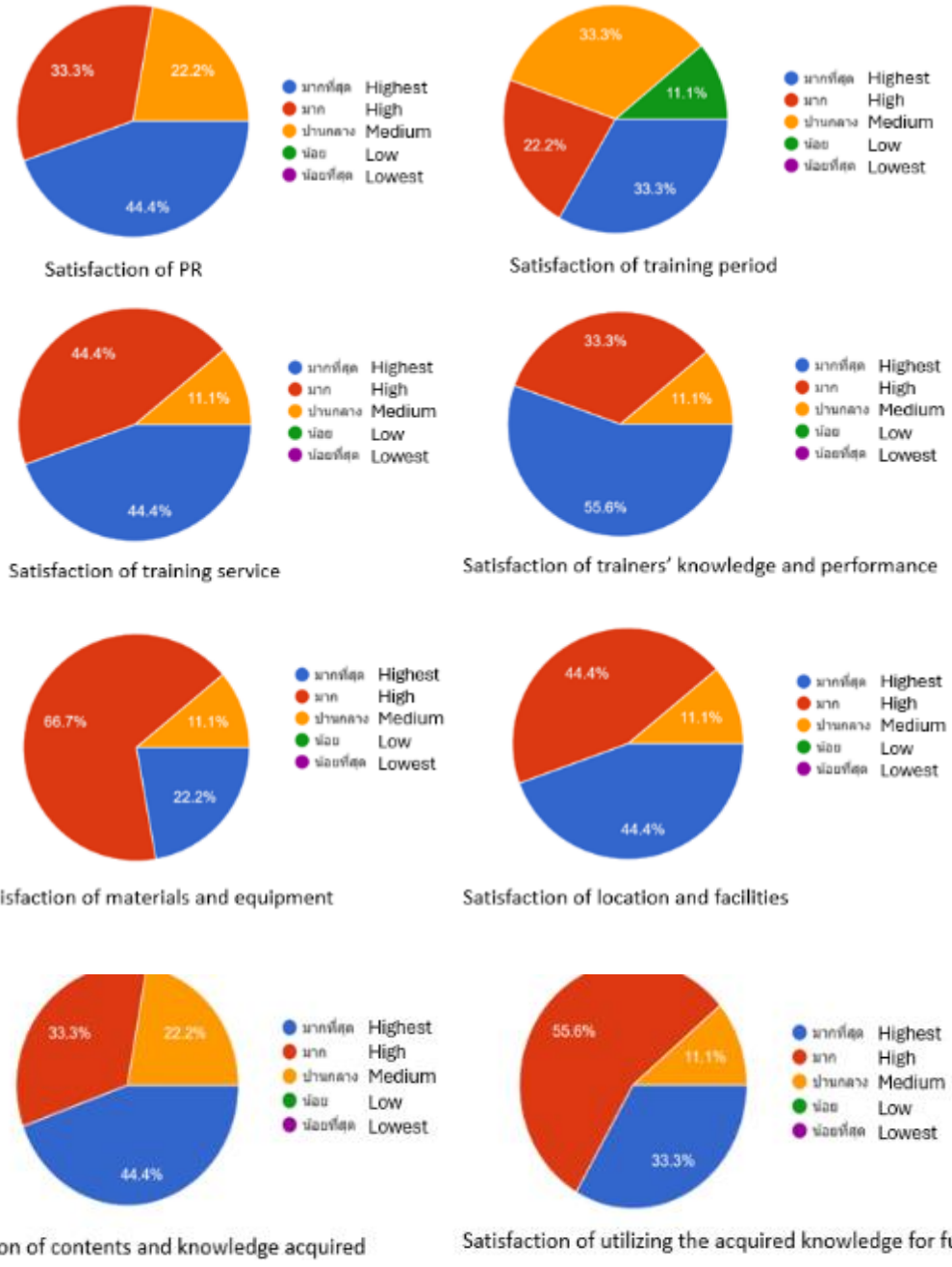

Figure 7. Levels of satisfaction with the training course.

Upon finishing the training, all participants were requested to assess the course they had recently completed. The questions were uploaded on Google Drive; the participants completed the evaluation anonymously. The assessment covered four domains:

a. Course Training: Including duration, location, facilities and training room, equipment and accessibility, course materials and activities.
b. Instructors' Performance: Covering the clarity of explanations, knowledge proficiency, and teaching skill and experiences.
c. Course Content: Evaluating its relevance and trending, its application.
d. Trainer's learning: level of knowledge /learning and level of experience on the topic

Each question is rated on a scale from 1 to 5, with 1 representing the lowest and 5 representing the highest score. The summary of the evaluations is presented as illustrated in figure 7.

Figure 8, on its turn, assesses the learning achievement perceived by participants and witnessed by the results of the tests.

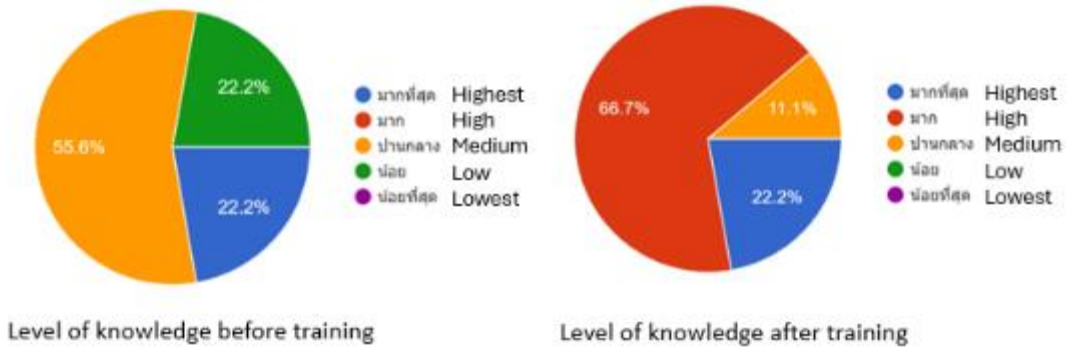

Figure 8. Levels of knowledge before and after the training.

Overall, the attendees expressed high satisfaction with the training, instructors, and course content. The results indicated that participants gained more knowledge and skill after the training, although they had different knowledge background and education level. Besides, they expressed confidence in their ability to apply the knowledge gained from the training course to advance their careers and for practical use. The survey results showed that the knowledge acquired can be applied for research work, management of agricultural waste for existing resources for beneficial outcomes, management of waste in the communities and enhance agricultural development. Composting and biochar production can be used for waste management in farms to improve soil quality and maximize fruit production in orchards and optimize various uses and promoting agriculture by utilizing unused materials. The knowledge can also be applied in household businesses and enhances animal nutrition in feed.

Finally, figure 9 shows the level of achievement of key success indicators set for the training programme.

Indicator for the success	Results
1. Training attendance in 1-day training/ each series.	1. 100%
2. Number of training course provided during SWAP programme.	2. 30 -40 people
3. Trainers and trainees' satisfaction	3. highest (88-90%)
4. Completion rate	4. 100%
5. Transfer of training knowledge for waste utilization	5. Implementation from the trainer
6. Number of products and entrepreneurship	6. 50%
7. Financial and investment	7. 100%

Figure 9. Comparison the results with the key success

LOOKING AHEAD

The agricultural waste management is significant in regional and local areas. This waste creates problems for human health, animals, and the environment. To bridge this gap and align with Thailand's sustainable development goals (SDGs), it is essential to establish a development framework and practical guidelines for Thai farmers to transform agro-residues into high-value assets for industrial agriculture. However, the shift towards a circular economy in agricultural communities continues to pose a substantial obstacle.

The training on "Agricultural waste utilization" would match the needs of the communities, local municipalities, farmers, and SMEs because these target groups are already confronted with the problems and realized how important to well managed this waste properly. The training will offer participants an opportunity to comprehend the options and technologies they can apply within their own context. The value-added products from agricultural waste will create income for the organizations and communities as well as environmental problems reduction in their communities simultaneously. Hence, this subject matter of the training hub is likely to swiftly capture the interest of the intended audience.

The sustainable agriculture is also the main agenda for Maejo university, we have great connection with local municipality and local communities through university activities and academic services. This topic would get attention from the university and partners for funding to future support the training hub and promote for more number of attendances. The cost of the training could also be kept low as it is also one part of academic service of staff duty. The raw materials for the training hub should be derived from community-based issues, which can vary from one location to another. The training facility should be either at the university with all the required resources or at the communities. The potential costs that the training hub may incur encompass the maintenance expenses for the machines, which should be incorporated into the training hub's budget and the transportation cost for the attendees who live far from Maejo university. It is also essential to sustain relationships of participants while conducting data collection and analyzing and organizing the database. Moreover, public-private investment and partnership is another important driving force for training hub sustainability and it is one of the key successes for PR and gain more interests to broader community.

Financial projections over 5 years

The expenses of the first training are shown in Table 2.

Table 2. Costs in a 3-day training course (March 2023)

Categories	Cost (THB)
Trainer's fee (9 hrs for lecture (rate 600 THB/hr) and practices (rate 300 THB/hr)	10,800
Break and lunch (30 participants)	12,750
Materials (materials, chemicals, office supplies, printings)	50,000
Total	73,550

Note: This budget supported by Maejo university.

The cost breakdown in Table 2 illustrates that the total expenditure for approximately 30 participants over the course of the 3-day activities amounted to 73,550 THB. Notably, expenses related to operation cost such as trainer's fee, coffee break and lunch and materials. It's important to note that the table does not account for ongoing maintenance of the machines or

equipment's and the overhead charge from the university and faculty. While maintenance was not necessary during this period due to their relatively new condition, these maintenance expenses should be factored into future budget considerations. The cost for participation fee is set at 500 per person/series.

Based on the MJU training hub plan, there will be at least two training courses per year, with anticipated participants being 25 per course. The financial projection of the MJU training hub is shown in Table 3.

Table 3. Financial projection of MJU training hub (5 years)

Income	**2023 (Year 1)**	**2024 (Year 2)**	**2025 (Year 3)**	**2026 (Year 4)**	**2027 (Year 5)**	**Total**
Funding from University	20,000	20,000	20,000	20,000	20,000	100,000
Sponsorship from Private Companies	5,000	5,000	5,000	5,000	5,000	25,000
Registration Fee (500 THB / person)	25,000	25,000	25,000	25,000	25,000	125,000
TOTAL INCOME	50,000	50,000	50,000	50,000	50,000	250,000

all values are in THB

Expenditure	**2023 (Year 1)**	**2024 (Year 2)**	**2025 (Year 3)**	**2026 (Year 4)**	**2027 (Year 5)**	**Total**
Materials and supplies	10,000	10,000	10,000	10,000	10,000	50,000
Meals	10,000	10,000	10,000	10,000	10,000	50,000
Repairs and maintenance	5,000	5,000	5,000	5,000	5,000	25,000
Trainers fee	5,400	5,400	5,400	5,400	5,400	27,000
Overhead charge (1%)	500	500	500	500	500	2500
TOTAL EXPEND.	30,900	30,900	30,900	30,900	30,900	152,500

all values are in THB

The 5-year financial projection shows that the training hub could maintain its activities on the assumption of 2 courses annually. The net income obtained from the training hub is approximately 19,100 TBA/year. The financial projection suggests that the training hub would operate efficiently under this scenario. Nonetheless, in the event of unexpected financial challenges, the option to exclude meal expenses could significantly reduce the overall operational costs, potentially balancing the budget.

APPENDIX

We report here some pictures and material of the inauguration day and from the course delivery.






Figure A1. First Training inauguration

Figure A2. Training materials

Figure A3. Physical training hub


SWAP


AO Labscan

Figure A3. Training hub on Agricultural waste utilization: Machine and equipment

Figure A4. Training hub products

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of the European Union

SWAP
Sustainable solid WAste management and Policies

Report from Hue University of Agriculture and Forestry (HUAF)

Vietnam

Main Authors: Le Thi Thuy Hang and Hoang Thi Thai Hoa

Topic of the Training Hub	Solid waste management
Physical address	Department of Crop Science HUAF University 102 Phung Hung street Hue City Vietnam
Official inauguration date of premises	May 17, 2023

INTRODUCTION

Hue University of Agriculture and Forestry (HUAF) was established in 1967 as one of the leading universities in the field of agriculture, rural development, aquaculture, animal sciences, food technology, environmental and natural resource management in Vietnam. The mission of HUAF is to train and provide high-quality human resources, advanced and effective scientific and technological products for the Central and Central Highlands regions and the whole country towards integration and development.

According to statistics, the total volume of Vietnam's agricultural, forestry and fishery by-products in 2020 is over 156.8 million tons. If we can take advantage of this available material as fertilizer, then we can meet enough consumer demand and aim for export instead of using chemical fertilizers. According to recent research results of the Ministry of Agriculture and Rural Development, the amount of crop by-products has high nutritional value (from 45-70% of the total digestible nutrients) and is capable of providing a large amount of nutrients calories (1,662 – 2,549 kcal/kg dry matter) for soil and plants. Therefore, agricultural waste are considered as the most beneficial organic fertilizer materials for crops and arable land.

With the mentioned above situation, HUAF set up the Training Hub "Solid Waste Management" (so called SWAP Training Hub) funded by the SWAP project of the Erasmus+ program. The SWAP Training Hub is located at Department of Crop Science belonging to the main campus of HUAF. The inauguration of the Training Hub took place on 17th May 2023.

DESCRIPTION

GOALS

Goals of the SWAP Training Hub: to be the leading Training Hub on Solid Waste Management in Central Vietnam and the whole country towards environmental protection.
Specific objectives:

- to support the academic and administrative staff in modernization and updating the SWM curricula of the Bachelor and Master levels;
- to support the university's staff to run TVET courses or informal educational products;
- to develop high quality research on SWM to meet the labor needs in market;
- to become a member of SWM networking at national, regional and international levels.

STEPS TAKEN TO START THE TRAINING HUB

- *Needs and situation assessment*: the SWAP team held a meeting with the representatives of relevant stakeholders and private enterprises to discuss what the needs of labour market in the field of solid waste management are. From that, we could identify what the training topics and research orientation are, who involve in the training hub and what resources and facilities are required.
- *Fundraising*: this step is very crucial to decide the sustainability of the SWAP training hub or not. In the first one years, the training hub could be run smoothly with the support of SWAP project and university funds. After ending the SWAP project, we have to seek budgets from training activities, consultants, technology transfer or research projects.
- *Physical location & Equipment purchase*: A meeting was held with the participation of university's leaders and the SWAP team aimed at the development of a plan to set up the Training Hub. The SWAP training hub is located at Department of Crop Science. Another larger room is assigned to the SWAP Training Hub for seminars, workshops or meetings. Besides, the experiments is implemented at Centre for Agricultural Research and Services. In terms of equipment, we could exploit the available existing equipment from the university.

Also, the SWAP training hub is funded the equipment purchase from the SWAP project of Erasmus+ program.

- *Operation*: During the operation of the SWAP training hub, we have to seek the partnerships and cooperation from local, national and international organizations and private industry enterprises.

PREMISES

The SWAP training hub is a training and research hub in the field of solid waste management under the management of Rector Board of Hue University of Agriculture and Forestry. It's provided a laboratory room, a meeting room and class rooms and facilities to run smoothly. All premises are located inside the University.

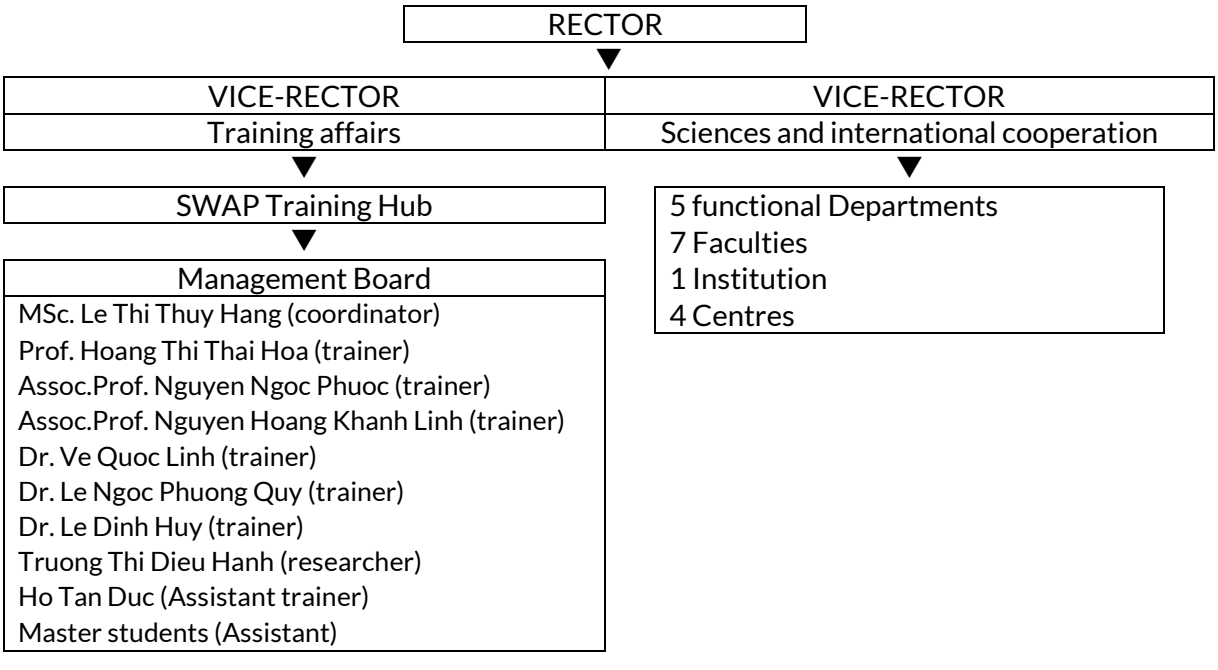
EQUIPMENT

The equipment of the SWAP training hub is provided by SWAP project funds under the Erasmus+ program:

No.	Item	Quantity
1	Universal oven	1
2	Handheld Water Quality Meters	1
3	Webserver	1
4	Laptop	4
5	HP 404DN Printer	1
6	Desktop	1
7	Photocopy	1

MANAGEMENT STRUCTURE/HUMAN RESOURCES/GOVERNANCE TEAM

The SWAP Training Hub is directly managed by Rector Board of Hue University of Agriculture and Forestry (HUAF). It is governed by a Management Board composed of 10 members, of which 3 -appointed by Department of Sciences & International Cooperation, Department of Training Affairs and Department of Planning & Finance- in charge of administrative and financial affairs, and 7 -appointed by Faculties- in charge of technical matters.



ACTIVITIES

ACTIVITIES/SERVICES PERFORMED

- **Delivery of Bachelor course "Solid Waste Management"**
  Date: 23rd-26th May 2023
  Number of participants: 38 Bachelor students
  Short description: After updating and modernization, the lecture of "Solid Waste Management" course was delivered the first class with the participation of 38 Bachelor students during 4 days.

- **Delivery of Bachelor course "Environmental Management of Urban and Industrial Zone"**
  Date: 18th-21st September 2023
  Number of participants: 25 Bachelor students
  Short description: After updating and modernization, the lecture of "Environmental Management of Urban and Industrial Zone" course was delivered the first class with the participation of 25 Bachelor students during 4 days.

- **Delivery of Master course "Environment and Sustainable Development"**
  Date: 15th -18th August 2023
  Number of participants: 19 Master students
  Short description: After updating and modernization, the lecture of "Environment and Sustainable Development" course was delivered the first class with the participation of 19 Master students during 4 days.

- **Delivery of TVET: Agricultural waste utilization into organic fertilizer for crop production**
  Date: 17-18th May 2023
  Number of participants: 36 participants (9 participants from government agency and private enterprises, 4 lecturers and 23 from graduates)
  Short description: To provide general and in-depth knowledge about the process to make organic fertilizer from agricultural wastes and use it for crops in a safe and sustainable manner.

- **Technology transfer service:** A contract between the company VIPESCO company and the HUAF has been signed to transfer technology on organic fertilizer production from agricultural waste

- The project on **"Household model development on biochar application from agricultural waste for crop production in Thua Thien Hue province"** funded by Thua Thien Hue province Department of Science and Technology from 2021-2022

- **Organization of "Information Day" event**
  Date: Afternoon 1st December 2022
  Number of participants: 171 participants involved in the "SWAP Information Day" event of whom 11 are representatives of enterprises, 48 are high school pupils, 112 are university students and 4 are HUAF staff
  Short description: To attract the prospective students to enrol the Bachelor and Master programmes updated relating to "Sustainable Solid Waste Management and Policies'; To promote the TVET training courses to the companies.

- **Organization of raising awareness events:**

Title	*Date*	*Number of participants*	*Short description*
1st event: Waste Sorting Education	01/12/22	160 students and high school pupils	To raise awareness and knowledge of the high school students on solid waste sorting, solid waste problems. To encourage high school students and their parents sort waste at their home, their school
2nd event: Painting Day for Future Environment	15/04/23	50 pupils and 7 teachers of Chu Van An secondary school	To raise awareness and knowledge of the children at secondary school on current environment problems as well as solid waste pollutions; To engage children in a creative exercise to identify their hopes and dreams of the future environment
3rd event: Waste recycling contest towards Green Campus	26/04/23	40 HUAF students	To raise awareness and knowledge of the university students on solid waste problems and how to recycle waste; To encourage students to find creative and innovative solutions to the solid waste challenges today.

POSSIBLE FUTURE COOPERATIONS

In order to ensure sustainability of the SWAP training hub, it's very crucial to seek the external collaborations for fundraising. That is why we are paving the way to cooperate in research and training activities with industry sector such as Mekong Binh Dien Joint Stock Company, VIPESCO company, co-operative society, HEPCO company.

FINANCIAL STATE OF PLAY

Presently, The SWAP training hub has been operated with the financial support from university and SWAP project. After ending the SWAP project, its earnings for the projection for the next 3 to 5 years will get from fees from training activities, consultant and technology transfer services or research projects.

ASSESSMENT SO FAR

What worked well: positive results

The raising awareness in young generation on solid waste management is one of the most significant activities that we have done well so far. The young generation help us to disseminate knowledge on solid waste management practices to family members and community.

Through the initial collaboration with private enterprises and stakeholders in the framework of SWAP project, we have close cooperation in training and research activities in next time.

We have received the strong support from university leaders to facilitate the SWAP training hub activities to run smoothly.

What could have worked better: problems and solutions found

It's much necessary to improve facilities in laboratory for teaching staff and students to do research and experiments.

It's very important to give more opportunities for academic staff to improve their capacity in teaching and research.
We need to build a network at local, national and international level to share information on collaboration and resources in the field of solid waste management aiming at improving facilities and capacities.

Our final judgment about this period
In general, the SWAP training hub has been the initial base for implementing sustainable solid waste management practices. While operating the SWAP training hub, we face many challenges and opportunities. However, we hope that the SWAP training hub will be a leading hub in training and research in the field of sustainable solid waste management in Central Vietnam and the whole country.

LOOKING AHEAD

What we see positive for the future
The needs of labour market on solid waste management will be high because this is one of the strategies that Vietnamese government has paid more attention in country economic development in future. The diversification of training topics will attract many potential learners.

What we see challenging for the future and possible solutions
The improvement of community's awareness in sustainable solid waste management is a challenge. Also, the sustainability of the SWAP training hub requires a lot of human and financial resources and a lot of time. We hope that the positive results can attract participants to the courses, and that we will be able to continue receiving support from the University, as well as gathering funds from private participants, sponsors and companies.

APPENDIX

Figure A1. Inauguration of SWAP Training Hub at HUAF

Figure A2. Info day event

Figure A3. First awareness raising event

Figure A4. Second awareness raising event

Figure A5. Third awareness raising event

Figure A6. The TVET course

Figure A7. The Master course

Figure A8. The Bachelor courses

Figure A9. Comments from participants

Co-funded by the Erasmus+ Programme of the European Union

SWAP
Sustainable solid WAste management and Policies

Report from Thai Nguyen University of Agriculture and Forestry (TUAF)

Vietnam

Main Author: Truong Thi Anh Tuyet

Topic of the Training Hub	Municipal solid waste management
Physical address	Faculty of Environment TUAF University Quyet Thang Commune Thai Nguyen City Thai Nguyen Province Vietnam
Official inauguration date of premises	September 27, 2023

INTRODUCTION

Thai Nguyen University of Agriculture and Forestry (TUAF), founded in 1969, stands as a leading institution in the realm of fisheries, aquaculture, agriculture, forestry, rural development, environmental and natural resource management in Vietnam. It also holds a prestigious reputation in Southeast Asia. Our main campus, nestled in Thai Nguyen City, Vietnam, spans over 100 hectares. The university comprises 8 Faculties, 2 Institutes, 8 Centers, and 8 Offices.
Vietnam is among the top five nations globally responsible for approximately 60% of oceanic plastic pollution. From 2010 to 2019, solid waste production in Vietnam surged by 46%. Alarming statistics reveal that roughly 85% of generated waste in Vietnam is consigned to unprocessed landfill sites, with 80% of them being unhygienic, causing environmental contamination. Awareness about waste management is limited, and there is a scarcity of training facilities addressing this issue.
In pursuit of rectifying this situation, we have established the Solid Waste Management Training Hub with the support of Sustainable Solid Waste Management and Policy project funded by ERASMUS+ Program. As part of this endeavor, we've inaugurated the Training Hub at Thai Nguyen University, managed by the Faculty of Environment. This hub features an administrative office and a laboratory for experiments and training on the second floor of the Faculty of Environment building.
The grand opening of this Training Hub took place on September 27, 2023.

DESCRIPTION

GOALS

The Training Hub at Thai Nguyen University of Agriculture and Forestry aims to provide advanced education, research, and skills development in the fields of solid waste management. It strives to foster innovation, sustainability, and excellence in these crucial domains. The specific goals include:

- to improve capacity and practical skills for lecturers, students, and non-academic workers in the field of solid waste management with more focus in organic waste.
- to promote research and public awareness activities related to solid waste management.
- to connect with businesses, state management agencies and experts in domestic and foreign training institutions.

STEPS TAKEN TO START THE TRAINING HUB

The establishment of the Training Hub involved securing funding, identifying key resource personnel, creating curriculum, and developing partnerships with relevant stakeholders in the region.

The establishment of the Training Hub at Thai Nguyen University of Agriculture and Forestry involved several key steps:

- **Situation analysis**: The project team conducted discussion with faculties, enterprises to identify the demand for training and research in the fields of solid waste management. This step helped in understanding the specific educational and research requirements. Also, human and finance resources were discussed to find out the sustainable strategies of the training hub.
- **Funding and Resource Allocation**: Securing funding and allocating resources for the Training Hub was a critical step. This involved obtaining financial support from the University, international organizations, and private donors.

- **Syllabus Development**: A team of experts and educators collaborated to design syllabus that aligns with the goals and objectives of the Training Hub.
- **Infrastructure Setup**: The university invested renovating appropriate facilities to house the Training Hub. This included the development of an administrative office, classrooms, laboratories and research spaces.
- **Equipment Procurement**: To ensure that the Training Hub could offer high-quality education and research opportunities, equipment were procured. This included computers, research tools and equipment supported from the SWAP project and the university.
- **Partnerships and Collaborations**: To enhance the impact and reach of the Training Hub, the university established collaborations with local and international organizations, governmental bodies, and industry stakeholders. Memorandums of Understanding (MoUs) and agreements were signed to facilitate knowledge exchange, joint research, and resource sharing.

PREMISES

The Training Hub is operated as a research and training hub under the management of Faculty of Environment. It includes equipped with classrooms, laboratories, and research spaces. It provides a conducive environment for learning and practical activities.

EQUIPMENT

The Training Hub is equipped with research tools, computers, and specialized tools for agriculture and forestry studies such as:

- solid waste crushers;
- biochar/AC production equipment (incinerator);
- drone for waste volume estimation;
- an administrative room, a training room, computer and projector.

MANAGEMENT STRUCTURE/HUMAN RESOURCES/GOVERNANCE TEAM

The Training Hub is led by a manager and is supported by a team of experienced educators and administrators. The governance team oversees the day-to-day operations and strategic direction.

Main responsible organization
Faculty of Environment

▼

Management representative
Dr. Nguyen Duy Hai

▼

Trainers
Prof. Dr. Dang Van Minh (Lead trainer)
Assoc. Prof. Dr. Do Thi Lan (Trainer)
Dr. Nguyen Duy Hai (Trainer)
Dr. Nguyen Duy Hai (Trainer)
Dr. Du Ngoc Thanh
Dr. Tran Thi Pha (Trainer)
Dr. Tran Hai Dang (Trainer)
MSc. Duong Thi Minh Ngoc
MSc. Hoang Thi Lan Anh
1 PhD (Ms. Duong Thi Minh Hoa)
2 Master students (Assistant trainers)

ACTIVITIES

Activities of Training Hubs at TUAF were divided into three groups including capacity building, research and awareness raising. They started well before the official ceremony of inauguration.

Capacity building

From December 2022 to October 2023, the training hub performed several courses for non-academic and academic groups. They are listed in table 1.

Table 1. List of training courses

Activities	*Period*	*Duration*	*Target group*	*Number of participants*	*Funding*
Training on waste Sorting and Segregation	01/04/2023-30/07/2023	1 hour/class x 10 class	Farmers	200	Bac Kan Province
Training on Composting and Organic Waste Management	01/06/2023-30/08/2023	2 hour/class x 10 class	Farmers	250	Bac Kan Province
Training on Biochar application	01/09/2023-30/10/2023	3 hour/class x 10 class	Farmers and students	30	Asia-Pacific Network on Climate Change

Research

With the support of SWAP project in equipment, two students' scientific research projects were conducted to promote biochar application. Together, the training hubs created a research network to promote research on solid waste management.

Awareness raising

Together with academic activities, the training hubs collaborated with Youth Union and Environmental Club of TUAF to carry out public awareness raising activities, such as a workshop on the world environmental day and a seminar for young people, students from high schools in Vietnam and in the Philippines were involved.

Date	*Activity*	*Target group and number of participants*	*Dissemination channel*
8/12/2022	Seminar on circular economy	30 TUAF students, student exchange (Indonesia) and high school from schools in Philippines	Face-to-face at TUAF
5/6/2023	World Environmental Day	50 TUAF students, leaders of Environmental Protection Division, Thai Nguyen province	Meeting at TUAF

POSSIBLE FUTURE COOPERATIONS

We have forged partnerships with a range of organizations and companies, such as Khoi Nguyen Science and Technology Joint Stock Company and EJC Thai Nguyen Joint Stock Company. Our collaborative efforts have been solidified through the signing of Memoranda of Understanding (MoUs), outlined in the attached annex. These MoUs are instrumental in promoting research and education, with our partners actively contributing to the development of both professional and soft skills for our graduate students, as well as participating in employee recruitment initiatives.

FINANCIAL STATE OF PLAY

Currently, in the first year, activities of the project were funded by the University (infrastructures), research projects (payment for trainers) and organizing training courses. While we have not seen returns yet, the university will anticipate funds for financial sustainability also for year 2024.

ASSESSMENT SO FAR

What worked well: positive results

- *Support from the University and Faculty* to maintain and operate activities of the training hub
- *Positive Engagement:* the Training Hub received enthusiastic participation from students, faculty, and partners, resulting in a growing interest in solid waste management.
- *Knowledge Dissemination:* Valuable knowledge and skills have been imparted to participants, contributing to better waste management practices.
- *Collaboration with Partners:* Our partnerships with organizations and companies, such as Khoi Nguyen Science and Technology Joint Stock Company and EJC Thai Nguyen Joint Stock Company, have yielded productive collaborations.

What could have worked better: problems and solutions found

- *Limited Resources:* Since the training hub was newly established, insufficient resources, both financial and physical, posed challenges in expanding and enhancing the Training Hub. To address this, we can explore additional funding sources, seek grants, and tap into community support.
- *Awareness and Participation:* While engagement was generally positive, increasing awareness and participation, especially among the broader community, could have been improved. We can consider marketing and outreach strategies to boost engagement.
- *Infrastructure:* The Training Hub's physical infrastructure, particularly the laboratory and training facilities, may need further improvement to accommodate a larger number of participants. Renovation and expansion plans should be considered.

Our final judgment about this period

Overall, the Training Hubs on Solid Waste Management have made significant strides in promoting sustainable waste management practices, fostering collaborations, and educating participants. While there were challenges, the foundation has been laid for a promising future. With determination, adaptation, and strategic planning, the Training Hubs can continue to be a valuable resource for addressing solid waste management issues in the region.

LOOKING AHEAD

What we see positive for the future

- *Growth Potential:* The Training Hub has laid a strong foundation for sustainable solid waste management. With continued effort of faculty staff and fund raising, activities of the training hubs can be extended both quantities of trainees and diversity of activities. Thereby, it can

potentially contribute to enhancing capacity building and addressing waste issues in the region.

- *Knowledge Transfer:* The knowledge and skills acquired by participants are likely to have a cascading effect in the community and industry, promoting better waste management practices.

What we see challenging for the future and possible solutions

- *Sustainable Funding:* Securing long-term funding for the Training Hub could be challenging. Exploring partnerships, grants, and alternative funding sources will be essential to sustain its operations.
- *Community Engagement:* Increasing participation and awareness among the local community may remain a challenge. Continuous outreach and education programs are necessary to address this issue.
- *Evolving Regulations:* As waste management regulations may change, staying updated and adapting to new requirements is vital. Collaboration with relevant authorities can help navigate any regulatory challenges.

APPENDIX 1 – PICTURES OF LOCATION AND ACTIVITIES

Figure 1. Training hub office

Figure 2. Training hub location

Figure 3. Training for students on waste classification

Figure 4. Training for students on application of drone in waste management

Figure 5-10: From April -October 2023, TUAF training hub conducts TVET trainings for more than 200 farmers in Bac Kan provinces on waste classification and organic waste management

Figure 11. Seminar on sustainable waste management and circular economy for high schools

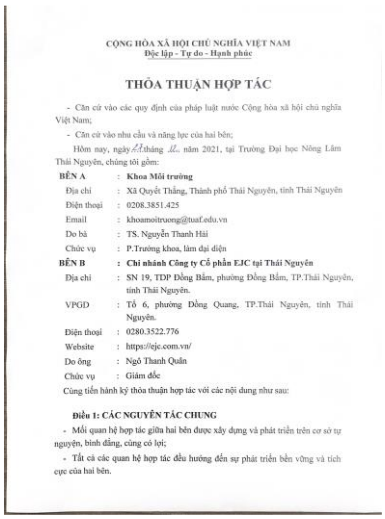
Figure 12. Public awareness on world environmental day

Figure 13. Public awareness through social media

Figure14. Cleaning day
(regular activities run by Environmental club)

APPENDIX 2 – MoU WITH STAKEHOLDERS

We provide here scan copies of the two Memoranda of Understanding we signed for cooperation in the framework of the training hub.



CỘNG HÒA XÃ HỘI CHỦ NGHĨA VIỆT NAM
Độc lập - Tự do - Hạnh phúc

THỎA THUẬN HỢP TÁC

- Căn cứ vào các quy định của pháp luật nước Cộng hòa xã hội chủ nghĩa Việt Nam;
- Căn cứ vào nhu cầu và năng lực của hai bên;

Hôm nay, ngày 21 tháng 12 năm 2021, tại Trường Đại học Nông Lâm Thái Nguyên, chúng tôi gồm:

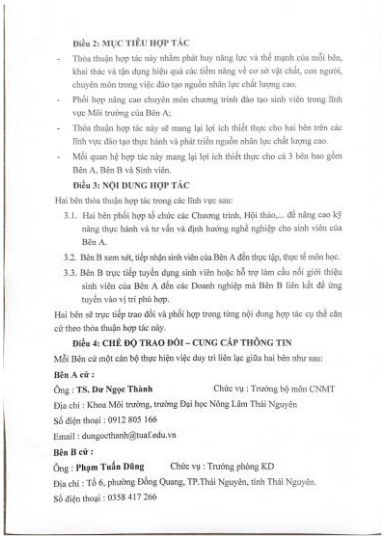
BÊN A : **Khoa Môi trường**
Địa chỉ : Xã Quyết Thắng, Thành phố Thái Nguyên, tỉnh Thái Nguyên
Điện thoại : 0208.3851.425
Email : khoamoitruong@tuaf.edu.vn
Do bà : TS. Nguyễn Thanh Hải
Chức vụ : P.Trưởng khoa, làm đại diện

BÊN B : **Chi nhánh Công ty Cổ phần EJC tại Thái Nguyên**
Địa chỉ : SN 19, TDP Đồng Bầm, phường Đồng Bầm, TP.Thái Nguyên, tỉnh Thái Nguyên.
VPGD : Tổ 6, phường Đồng Quang, TP.Thái Nguyên, tỉnh Thái Nguyên.
Điện thoại : 0280.3522.776
Website : https://ejc.com.vn/
Do ông : Ngô Thanh Quân
Chức vụ : Giám đốc

Cùng tiến hành ký thỏa thuận hợp tác với các nội dung như sau:

Điều 1: CÁC NGUYÊN TẮC CHUNG

- Mối quan hệ hợp tác giữa hai bên được xây dựng và phát triển trên cơ sở tự nguyện, bình đẳng, cùng có lợi;
- Tất cả các quan hệ hợp tác đều hướng đến sự phát triển bền vững và tích cực của hai bên.



Điều 2: MỤC TIÊU HỢP TÁC

- Thỏa thuận hợp tác này nhằm phát huy năng lực và thế mạnh của mỗi bên, khai thác và tận dụng hiệu quả các tiềm năng về cơ sở vật chất, con người, chuyên môn trong việc đào tạo nguồn nhân lực chất lượng cao.
- Phối hợp nâng cao chuyên môn chương trình đào tạo sinh viên trong lĩnh vực Môi trường của Bên A;
- Thỏa thuận hợp tác này sẽ mang lại lợi ích thiết thực cho hai bên trên các lĩnh vực đào tạo thực hành và phát triển nguồn nhân lực chất lượng cao.
- Mối quan hệ hợp tác này mang lại lợi ích thiết thực cho cả 3 bên bao gồm Bên A, Bên B và Sinh viên.

Điều 3: NỘI DUNG HỢP TÁC

Hai bên thỏa thuận hợp tác trong các lĩnh vực sau:

3.1. Hai bên phối hợp tổ chức các Chương trình, Hội thảo,... để nâng cao kỹ năng thực hành và tư vấn và định hướng nghề nghiệp cho sinh viên của Bên A.

3.2. Bên B xem xét, tiếp nhận sinh viên của Bên A đến thực tập, thực tế môn học.

3.3. Bên B trực tiếp tuyển dụng sinh viên hoặc hỗ trợ làm cầu nối giới thiệu sinh viên của Bên A đến các Doanh nghiệp mà Bên B liên kết để ứng tuyển vào vị trí phù hợp.

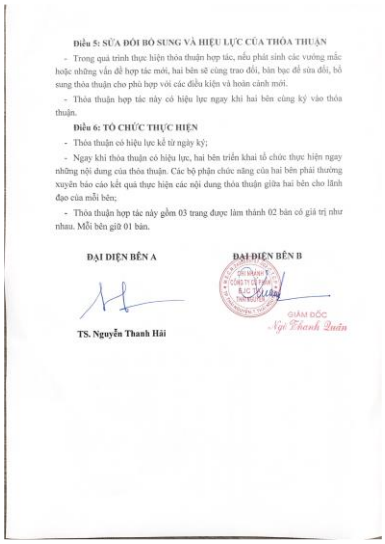
Hai bên sẽ trực tiếp trao đổi và phối hợp trong từng nội dung hợp tác cụ thể căn cứ theo thỏa thuận hợp tác này.

Điều 4: CHẾ ĐỘ TRAO ĐỔI – CUNG CẤP THÔNG TIN

Mỗi Bên cử một cán bộ thực hiện việc duy trì liên lạc giữa hai bên như sau:

Bên A cử :
Ông : **TS. Dư Ngọc Thành** Chức vụ : Trưởng bộ môn CNMT
Địa chỉ : Khoa Môi trường, trường Đại học Nông Lâm Thái Nguyên
Số điện thoại : 0912 805 166
Email : dungocthanh@tuaf.edu.vn

Bên B cử :
Ông : **Phạm Tuấn Dũng** Chức vụ : Trưởng phòng KD
Địa chỉ : Tổ 6, phường Đồng Quang, TP.Thái Nguyên, tỉnh Thái Nguyên.
Số điện thoại : 0358 417 266



Điều 5: SỬA ĐỔI BỔ SUNG VÀ HIỆU LỰC CỦA THỎA THUẬN

- Trong quá trình thực hiện thỏa thuận hợp tác, nếu phát sinh các vướng mắc hoặc những vấn đề hợp tác mới, hai bên sẽ cùng trao đổi, bàn bạc để sửa đổi, bổ sung thỏa thuận cho phù hợp với các điều kiện và hoàn cảnh mới.
- Thỏa thuận hợp tác này có hiệu lực ngay khi hai bên cùng ký vào thỏa thuận.

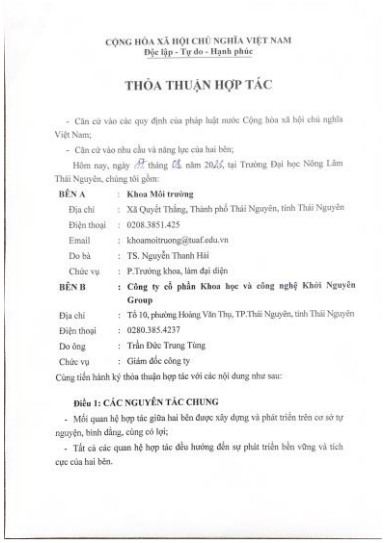
Điều 6: TỔ CHỨC THỰC HIỆN

- Thỏa thuận có hiệu lực kể từ ngày ký;
- Ngay khi thỏa thuận có hiệu lực, hai bên triển khai tổ chức thực hiện ngay những nội dung của thỏa thuận. Các bộ phận chức năng của hai bên phải thường xuyên báo cáo kết quả thực hiện các nội dung thỏa thuận giữa hai bên cho lãnh đạo của mỗi bên;
- Thỏa thuận hợp tác này gồm 03 trang được làm thành 02 bản có giá trị như nhau. Mỗi bên giữ 01 bản.

ĐẠI DIỆN BÊN A **ĐẠI DIỆN BÊN B**

TS. Nguyễn Thanh Hải

GIÁM ĐỐC
Ngô Thanh Quân



CỘNG HÒA XÃ HỘI CHỦ NGHĨA VIỆT NAM
Độc lập - Tự do - Hạnh phúc

THỎA THUẬN HỢP TÁC

- Căn cứ vào các quy định của pháp luật nước Cộng hòa xã hội chủ nghĩa Việt Nam;
- Căn cứ vào nhu cầu và năng lực của hai bên;

Hôm nay, ngày 17 tháng 12 năm 2021, tại Trường Đại học Nông Lâm Thái Nguyên, chúng tôi gồm:

BÊN A : **Khoa Môi trường**
Địa chỉ : Xã Quyết Thắng, Thành phố Thái Nguyên, tỉnh Thái Nguyên
Điện thoại : 0208.3851.425
Email : khoamoitruong@tuaf.edu.vn
Do bà : TS. Nguyễn Thanh Hải
Chức vụ : P.Trưởng khoa, làm đại diện

BÊN B : **Công ty cổ phần Khoa học và công nghệ Khôi Nguyên Group**
Địa chỉ : Tổ 10, phường Hoàng Văn Thụ, TP.Thái Nguyên, tỉnh Thái Nguyên
Điện thoại : 0280.385.4237
Do ông : Trần Đức Trung Tùng
Chức vụ : Giám đốc công ty

Cùng tiến hành ký thỏa thuận hợp tác với các nội dung như sau:

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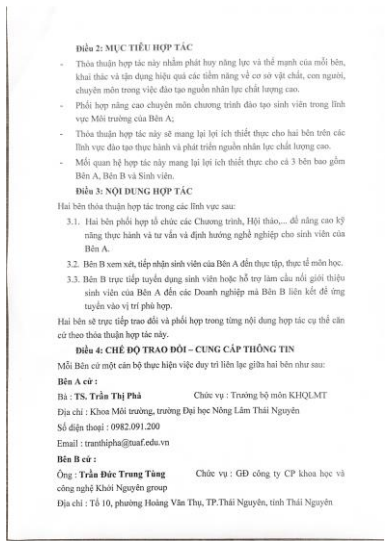

Điều 2: MỤC TIÊU HỢP TÁC

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- Mối quan hệ hợp tác này mang lại lợi ích thiết thực cho cả 3 bên bao gồm Bên A, Bên B và Sinh viên.

Điều 3: NỘI DUNG HỢP TÁC

Hai bên thỏa thuận hợp tác trong các lĩnh vực sau:

3.1. Hai bên phối hợp tổ chức các Chương trình, Hội thảo,... để nâng cao kỹ năng thực hành và tư vấn và định hướng nghề nghiệp cho sinh viên của Bên A.

3.2. Bên B xem xét, tiếp nhận sinh viên của Bên A đến thực tập, thực tế môn học.

3.3. Bên B trực tiếp tuyển dụng sinh viên hoặc hỗ trợ làm cầu nối giới thiệu sinh viên của Bên A đến các Doanh nghiệp mà Bên B liên kết để ứng tuyển vào vị trí phù hợp.

Hai bên sẽ trực tiếp trao đổi và phối hợp trong từng nội dung hợp tác cụ thể căn cứ theo thỏa thuận hợp tác này.

Điều 4: CHẾ ĐỘ TRAO ĐỔI – CUNG CẤP THÔNG TIN

Mỗi Bên cử một cán bộ thực hiện việc duy trì liên lạc giữa hai bên như sau:

Bên A cử :
Bà : **TS. Trần Thị Phà** Chức vụ : Trưởng bộ môn KHQLMT
Địa chỉ : Khoa Môi trường, trường Đại học Nông Lâm Thái Nguyên
Số điện thoại : 0982.091.200
Email : tranthipha@tuaf.edu.vn

Bên B cử :
Ông : **Trần Đức Trung Tùng** Chức vụ : GĐ công ty CP khoa học và công nghệ Khôi Nguyên group
Địa chỉ : Tổ 10, phường Hoàng Văn Thụ, TP.Thái Nguyên, tỉnh Thái Nguyên
Số điện thoại :0868.666. 690
Email : dkkd.thainguyen@gmail.com

Điều 5: SỬA ĐỔI BỔ SUNG VÀ HIỆU LỰC CỦA THỎA THUẬN

- Trong quá trình thực hiện thỏa thuận hợp tác, nếu phát sinh các vướng mắc hoặc những vấn đề hợp tác mới, hai bên sẽ cùng trao đổi, bàn bạc để sửa đổi, bổ sung thỏa thuận cho phù hợp với các điều kiện và hoàn cảnh mới.
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Điều 6: TỔ CHỨC THỰC HIỆN

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- Ngay khi thỏa thuận có hiệu lực, hai bên triển khai tổ chức thực hiện ngay những nội dung của thỏa thuận. Các bộ phận chức năng của hai bên phải thường xuyên báo cáo kết quả thực hiện các nội dung thỏa thuận giữa hai bên cho lãnh đạo của mỗi bên;
- Thỏa thuận hợp tác này gồm 03 trang được làm thành 02 bản có giá trị như nhau. Mỗi bên giữ 01 bản.

ĐẠI DIỆN BÊN A **ĐẠI DIỆN BÊN B**

TS. Nguyễn Thanh Hải

GIÁM ĐỐC
Trần Đức Trung Tùng

Co-funded by the Erasmus+ Programme of the European Union

SWAP
Sustainable solid WAste management and Policies

Report from Royal University of Agriculture (RUA)

Cambodia

Main Authors: Kim Soben, Yutha Nida

Topic of the Training Hub	Municipal solid waste management
Physical address	Faculty of Forestry Royal University of Agriculture Dongkor District Phnom Penh Cambodia P.O.Box: 2696
Official inauguration date of premises	November 11, 2023

INTRODUCTION

The Royal University of Agriculture (RUA) was founded in 1964 by the late royal father, His Majesty King Norodom Sihanouk, with the support of the French government, to provide higher education in agricultural sectors. On 27 December 1999, the university was declared a public administrative institution and has since been regarded as the first leading public institution in Cambodia to provide higher agricultural education and serve the government as the key player in the planning, production and distribution of agricultural professionals in the country. RUA is under the technical supervision of the Ministry of Agriculture, Forestry and Fisheries. It is accredited by the Ministry of Education, Youth and Sports and is financially supported by the Ministry of Economy and Finance.

RUA offers Associate, Bachelor, Master and PhD programmes to over 3,000 students annually. The Master's and PhD programmes include both research and study aspects. RUA's research and education focuses on agriculture, natural environment, food quality and markets (e.g. food safety, food processing, pre-harvest, harvest and post-harvest technologies, development of organisational models for farmers to ensure the quality of agricultural products, value chain studies to describe formal and informal agricultural production and marketing), agricultural engineering and appropriate technologies, and intensification and productivity improvement of arable, aquatic and livestock production systems. Besides, the current trend of waste in Cambodia is increasing gradually and need to be addressed, so the priority act is to provide education to people especially for young generation on the related topics such as introduction to sustainable waste management and circular economy, economic aspect on waste management, law and regulation on WM, etc.

On 11 November 2023, the Centre for Agricultural and Environmental Studies of the Royal University of Agriculture (CAES-RUA) officially opened a training hub which entitled “RUA Training Hub” for sustainable waste management, which provides skills and knowledge to students, farmers and unskilled workers, young researchers and relevant stakeholders. One of the priorities proposed by the government for appropriate and efficient food waste management is composting (Seng et al., 2020). Composting can reduce the volume of waste by 30-50% and the end product can be used as fertiliser to increase crop yields and improve the soil. As composting can reduce the volume of waste, it is also a good source of nutrients for plants as it contains around 2% N, 0.5-1% P and 2% K (Britannica, 2022). Compost contains 40-60% organic matter, which is a source of plant nutrients and can be used to improve the soil. The ratio of carbon to nitrogen (C:N) is 10-15:1, which means that the available nitrogen is released quickly enough for plant uptake, although chemical fertilisers work faster. Most plants and vegetables require a soil pH of 5.8-6.5 (Kluepfel and Lippert, 2012) or 5.5-7.5 (Penas and Lindgren, 1990). Composting can create such an environment for plant growth as it has a pH of 6-8 (USDA, 2000).

DESCRIPTION

GOALS

The goal of this hub is to provide services on waste management research, innovation, and business in Cambodia. The specific objectives are:

- to offer training services to government institutions, non-governmental organisations, communities, the private sector, local people, and informal workers in the field of waste management;
- to establish research partnerships among development partners, the public, private, and informal sectors;
- to support business plans for SMEs (small and medium enterprises).

STEPS TAKEN TO START THE TRAINING HUB

Needs and situation analysis: The SWAP team met with representatives of relevant stakeholders and private companies/industries to discuss the needs of the labour market in the field of waste management. This enabled us to find out what training topics and research priorities exist, who is involved in the training centre and what resources and facilities are needed.

Physical space: CAES-RUA set up a room to organise seminars or training courses in theory for about 100m^2 and a larger composting house for practice is about 140m^2.

Fund raising: To operate the Hub sustainably, CAES-RUA must encourage itself to operate the Hub from the outset with direct support from the project and stakeholder funds. After the SWAP project is completed, we need to seek budgets from training, consultants, technology transfer or research projects.

PREMISES

The RUA Training Hub is under the direct management of the Centre for Agricultural and Environmental Studies, which ensures that the facility is fully supported for training and sufficient equipment for the practice.

EQUIPMENT

Our sincere thanks and appreciation go to the SWAP project, supported by ERASMUS+ promramme, which enabled us to purchase the equipment for the initial set-up of the training hub on compost making for sustainable agricultural use.The purchased equipment is listed in Table 1.

Table 1: List of equipment of RUA Training Hub for compost making provided by SWAP

No.	Item	Quantity
1	Shredder	01
2	Screening machine	01
3	Wheel loader	01
4	Compost thermometer	03

MANAGEMENT STRUCTURE/HUMAN RESOURCES/GOVERNANCE TEAM

The training is designed and delivered by experienced lecturers and experts from RUA together with experts from COMPOSTED. They have years of experience in teaching, experimentation and compost production. There will be at least two lecturers in a course to ensure a diverse knowledge and the appropriate answers for the participants.

The management structure is shown in Figure 1.

The hub is divided into three units:

- Administration and Finance
- Knowledge Management
- Technical unit.

The Administration and Finance unit is responsible for all kinds of paperwork needed in the hub, communicating with relevant stakeholders such as resources, trainees from different institutions, organizing all kinds of trainings, and managing the financial flow of the hub. The Knowledge Management Unit is responsible for storing all resources related to the development of the courses and for publishing all activities carried out within the hub. The last unit includes the formation of a resource group and the collection of all necessary training materials to ensure that the course is appropriately delivered to the target audience.

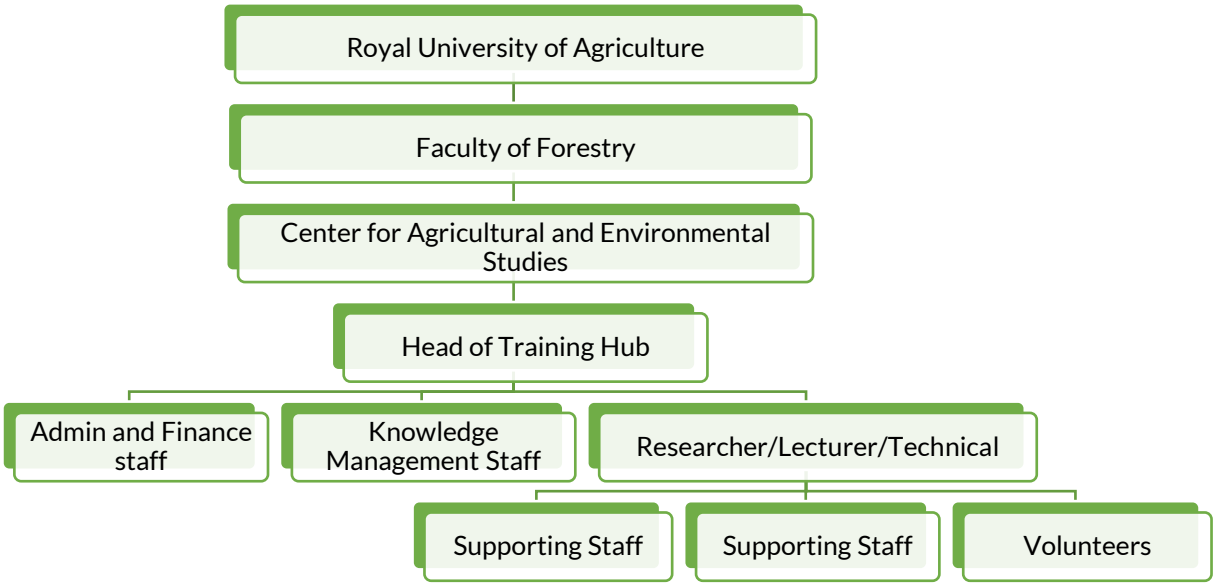


Figure 1: Structure of the RUA Training Hub

The staff assigned to the Hub at present is as follows:

1. Prof. Dr. Ngo Bunthan, Head of committee board of the training hub
2. Prof. Dr. Houn Thavrak, Deputy Head committee board of the training hub
3. Dr. Chiek Ang, member of committee board of the training hub
4. Mr. Kim Soben, Manager of the training hub
5. Mr. Som Phalla and Mr. Uch Rithy, technical support from COMPOSTED
6. Ms. Yutha Nida, support for knowledge management products and dissemination
7. Ms. Heng Chamroeun, lecturer
8. Mr. Sien Teamhy, lecturer
9. Mr. Yorn Chomroeun, lecturer
10. Mr. Mey Sila, technical assistant for compost making
11. Mr. Noun Tola, Technical assistant for compost making

ACTIVITIES

Activities started before the official inauguration, to test the functioning of the hub.

Events	*Date*	*Attendance*	*Short description*
National Dissemination Workshop on Sustainable Solid Waste Management and Policies (Zoom)	23/09/21	Around 100	To disseminate SWAP project to relevant partners and panel discussion on challenges and seeking opportunity for sustainable solid waste management and policies in Cambodia. The target participants are from NGOs, company, MoE, RUA, and UHST.
Dissemination Seminar on Municipality Solid Waste Management in Cambodia	29/12/22	44 (F=27)	1. Raise awareness of the initial concept of solid waste management, challenges, and environmental impact of SWM to the participants especially the young generation. 2. Disseminate laws and regulations related to solid waste management

Events	Date	Attendance	Short description
Compost Production for Sustainable Agriculture	10/03/23	35 (F=20)	To provide hand-on training on compost making
Capacity Building on solid waste management and recycling	16/06/23	30 (F=16)	To aware knowledge on solid waste management and circular economy and initial concept for business start-up
Inauguration Day	11/11/23	86 (F=57)	Introduction of RUA training hub with officially open the hub

POSSIBLE FUTURE COOPERATIONS

Regarding waste, RUA have an agreement with MIZUDA company for waste collection within the university and COMPOSTED collaboration to provide technical support for RUA staff and students. On the other hand, currently, we have contract negotiation with AgriNature company on provide technical training on earthworm compost making.

ASSESSMENT SO FAR

What worked well: positive results

Raising awareness of solid waste management among the younger generation is one of the most important activities we have done well so far. The young generation helps us to pass on knowledge about waste management to family members and the community.

What could have worked better: problems and solutions found

It is very important to improve laboratory facilities for teachers and students so that they can carry out research and experiments. It is very important to give academic staff more opportunities to improve their teaching and research skills. We need to build a network at local, national and international levels to share information on waste management co-operation and resources to improve facilities and capacities.

Our final judgment about this period

The SWAP Training Hub is the starting point for the implementation of sustainable waste management practises. During the operation of this hub, we face many challenges and opportunities, but we try our best to run it sustainably.

LOOKING AHEAD

What we see positive for the future

The demand in the labour market in the waste management sector is high, as this is one of the strategies that the RGC will pay more attention to in the future in order to promote economic development, especially in the tourism sector. The diversification of training topics will attract many potential learners.

What we see challenging for the future and possible solutions

Raising community awareness of sustainable waste management and finding resources and funding support are key challenges.

APPENDIX 1 – PICTURES

Figure A1. RUA training hub equipment and facilities

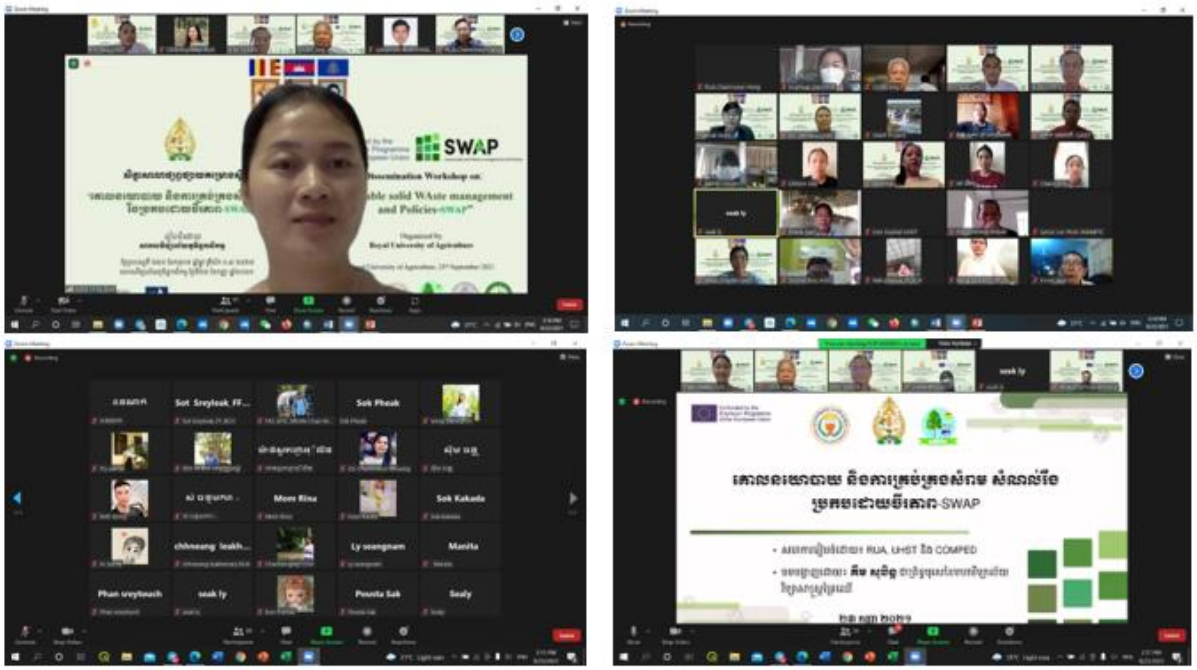


Figure A2. Dissemination workshop on "Sustainable Solid Waste Management and Policies", 23rd September 2021 via zoom

Figure A3. Dissemination Seminar on Municipality Solid Waste Management in Cambodia, 29th December 2022 at Faculty of Forestry classroom

Figure A4. Workshop on Compost Production for Sustainable Agriculture, 10th March 2023

Figure A5. Capacity Building on solid waste management and recycling, 16th June 2023

Figure A6. Opening day, official inauguration of RUA Training Hub, 11th November 2023

APPENDIX 2 – PRESS RELEASES FOR EVENTS

1. **National Dissemination Workshop on Sustainable Solid Waste Management and Policies (Zoom) (23rd Sept 2021)**

On 23rd September 2021, the Faculty of Forest Sciences of the Royal University of Agriculture collaborated with University of Heng Samrin Thboungkhmum, and organization of waste processing and education in Cambodia, organized a dissemination workshop on "Sustainable Solid Waste Management and Policy-SWAP" through ZOOM online. This project was funded by EU Erasmus+ CBHE which was coordinated by Hamburg University of Technology (TUHH), and implemented by 11 partners (Universities and stakeholders). The workshop was attended by high management level, professors, researchers and students of the Royal University of Agriculture, University of Heng Samrin Thboungkhmum, NGOs and relevant private sectors total 100 participants. The workshop has two main objectives: 1) to provide a general overview of the project, and 2) to discuss the challenges, opportunities and key concepts to develop policies and to improve the implementation of sustainable solid waste management projects in Cambodia. The workshop helped assess the current situation of Solid waste in Cambodia, contributed to an understanding of the issues faced by solid waste, and led to full understanding of the challenges of Solid waste management. This outreach workshop provided important messages and activities to target groups such as public authorities (local, regional, and national), the private sector, international organizations, NGOs, entrepreneurs, citizens, and all partners will carry out project promotion and dissemination, through its institutional network and other media.

2. **Dissemination Seminar on "Municipality Solid Waste Management in Cambodia" 29th December 2022**

Phnom Penh, on 29th December 2022, A great honor for Center for Agricultural and Environmental Studies of the Royal University of Agriculture (RUA) and the Environmental Education and Recycling Organization (COMPOSTED) to co-organized a-day of dissemination seminar on **"Municipality Solid Waste Management in Cambodia (MSWM)"** under SWAP project (www.swap-eplus.org) is co-funded by Erasmus+ programme. The specific objectives of this event are 1) to aware of the initial concept of solid waste management, challenges, and environmental impact of SWM to the participants especially for the young generation and 2) to disseminate laws and regulations related to solid waste management in Cambodia.

MSWM's dissemination was successfully completed under the led by Mr. Kim Soben, Dean of the Faculty of Forestry Science and Project Manager of SWAP and Mr. Sam Phalla, Executive Director of COMPOSTED and co-organized by Mrs. Yutha Nida, Project staff of SWAP based in RUA, Mr. Uch Rithy, Deputy Director of COMPOSTED, and Mr. Sok Pheak, Project staff of SWAP based in UHST and participated around forty participants who are students, staff, and lecturers of the Royal University of Agriculture.

The contents of this event are covered dissemination of laws and regulations related to solid waste management, current situation of Municipality Solid Waste Management in Cambodia, the impacts are not proper Solid Waste Management (impact on the environment, health problems, impact on the economy, impact on the Municipality), the challenge and environmental impact of SWM (Health effects were by soil, air, and water pollution, and the impact on the environment was by greenhouse gas (GHG) emissions and when landfills are not properly sealed, leachate - a liquid pollutant - seeps into groundwater and kills plants and animals), policies support and promote the implementation of the principle of 3R (Reduce, Reuse and Recycle) and organize and manage landfills in Cambodia (Support and promote the management of landfill in accordance with global technical standards and a sustainable environment).

3. Compost Production for Sustainable Agriculture

On 10 March 2023, the Centre for Agricultural and Environmental Studies of the Royal University of Agriculture organised a training course on "Compost production for sustainable agriculture". This project was funded by SWAP project of the Erasmus+ CBHE programme, coordinated by the Hamburg University of Technology (TUHH) and implemented by 11 partners (universities and stakeholders). The training was aimed to enhance the capacity and business plan on compost production and demonstration of the compost making process for soil improvement. The training was led by Prof Kim Soben and lecturers Uch Rithy, Chim Nguy and Yorn Chomroeun gave presentations and demonstrated the work at the CAES-RUA composting house. The participants are students from the Royal University of Agriculture, 35 in total, 20 of whom are women.

4. Capacity Building on solid waste management and recycling (16th June 2023)

On 16th June 2023, Center for Agricultural and Environmental Studies of the Faculty of Forestry of the Royal University of Agriculture organized a dissemination workshop on "Sustainable Solid Waste Management and Policy-SWAP" which was conducted on-site in the Royal University of Agriculture under the topic “Solid Waste Management and Recycling at the Royal University of Agriculture”. This project was funded by EU Erasmus+CBHE which was coordinated by Hamburg University of Technology (TUHH), and implemented by 11 partners (Universities and stakeholders).

The workshop has two main objectives; 1) Improve the knowledge of trainees on the management and recycling of solid waste in the university to be effective and correct to contribute to reducing the transfer of recyclable waste to landfills (ensure the life of the field), 2) Demonstrate the process of setting up a Training Hub and business plan (case study on composted). The workshop was led by Prof. Kim Soben and participated by lecturers; Mrs. Yutha Nida, Mr. Chim Nguy, and Ms. Yorn Chivka to give presentations and group discussions. The participants are students from the Royal University of Agriculture total of 30 participants. This workshop provided knowledge on recycling dry waste easily using wet waste as compost and good practice of waste segregation, it makes easier for waste collection.

5. Inauguration Day of RUA Training Hub

On 11 November 2023, the Royal University of Agriculture's Centre for Agriculture and the Environment, chaired by Prof. Kim Soben, Dean of the Faculty of Forestry, was officially open the RUA Training Centre. This centre is supported by the " Sustainable Solid Waste Management and Policies - SWAP" project of the ERASMUS+ programme.

The specific objectives of this training centre are 1). To provide training for government institutions, non-governmental organisations, municipalities, the private sector, the local population and informal workers in the field of waste management; 2). Establish research partnerships between development partners, the public, private and informal sectors; and 3). Supporting business plans for SMEs (small and medium enterprises).

Prof Kim Soben also mentioned that due to population growth, the whole world is suffering from the effects of waste. Municipal solid waste management is an important issue that all countries in the world, especially developing countries, urgently need to address. Solid waste includes organic waste, plastic waste, hazardous waste and electronic waste. Improper management of these wastes poses many risks to humans, animals and plants, which can lead to health problems, skin diseases, cancer, reproduction and so on. In addition, the discharge of improperly disposed wastewater into seas, rivers, lakes and groundwater can pollute soil and air. A total of 86 participants took part in this event, 57 of whom were women.

Co-funded by the Erasmus+ Programme of the European Union

SWAP
Sustainable solid WAste management and Policies

Report from University of Heng Samrin Thbongkhmum (UHST)

Cambodia

Main Authors: Mr. Pin Tara, Mr. Sok Pheak
Ms. Uon Sophal, Ms. Meas Sreylen

Topic of the Training Hub	Waste management through segregation and recycling
Physical address	Faculty of Agriculture University of Heng Samrin Thbongkhmum Nikum Leu Village, Sralap Municipality, Thbongkhmum District, Thbongkhmum Province, Cambodia
Official inauguration date of premises	June 26, 2023

INTRODUCTION

Solid waste management is an emerging concern for countries around the world, particularly developing nations with limited financial resources, lack of technologies, and an absence of policy framework. Waste management is the one of the biggest challenges in developing countries such as in Asia have serious environmental and public health problem. For the solid waste in Cambodia is classified into three categories; household waste, commercial waste, and industrial and hazardous waste (including medical waste). Cambodia has been among the fastest-growing economies in Southeast Asia, with an average annual GDP growth of 7% over the past five years. An increase in solid waste and associated challenges in solid waste management faced as a result of this rapid economic growth and subsequent rise in consumption. The amount of municipal solid waste increased sharply to over 4 million tons per year nationwide, with about 37% going to landfills, 12% recycled, and 51% illegally dumped or burned despite existing laws. The amount of waste disposed in landfills increased accordingly, from over 317,550 tons per year in 2004 to 1.5 million tons per year in 2017.

According to the Ministry of Environment, in Cambodia, the municipal waste amount of 1.7 million tonnes is disposed at 106 landfills in 2018, steadily increased of 205,656 tonnes or equal to 13.68% compared in 2017 and increased of 56.9% if compared in 2014 (MoE, 2018) , while the methane gas generated from landfill sites across Cambodia (four cities - Phnom Penh, Siem Reap, Battambang, Kampong Cham) is estimated to be as high as 360,000 tonnes CO2 equivalent per year , contributing to global climate change (Thumbnails, 2011).

In 2018, Cambodia generated a 10 percent increase per year in waste, while in 2019 Phnom Penh alone generated up to 3,000 tonnes of waste daily, and for the whole country producing over 10,000 tonnes is equivalent to 3.6 million per year (Khmer Times News, 2020). Municipal solid waste combine waste from household and commercials, generated from households, markets, restaurants, shops, hotels, offices, street sweeping, and miscellaneous. Phnom Penh generates around 4.09 million tons/year of solid waste that from household waste make up around 55.3% of the total, followed by hotels/guesthouses (16.7%), restaurants (13.8%), markets (7.5%), shops (5.4%) and offices (1.4%). Looking at type of waste, around half (51.9%) is food and other organic waste, one-fifth (20.9%) plastic and one tenth (9.9%) paper. Municipal solid waste treatment in Cambodia has three ways; landfill, recycling, and incineration. Also, the University of Heng Samrin Thbongkhmum (UHST) located in TbongKhmum province, Cambodia was inaugurated on 11th Feb 2016 by the Prime Minister of Cambodia. UHST provides education to rural youth who would not otherwise have access to higher education. UHST has area of land covered 22 ha for University Building, Library, Meeting Hall Building, Relaxing Place, Canteen, Reserved Building, venue for other relevant workshop and training, TVET Building, Laboratory, Agricultural Farm, Lecturer's Dormitory, Students' Dormitory, Football space. The university currently has around 1,170 students, and 600 students and 40 lecturers stay in the dormitory. Solid waste segregation and recycle is an essential activity for UHST. Current situation is that both lecturers and students have not understood about the solid waste management, particularly how to segregate properly between solid and liquid waste. Improvement of this activity will help the UHST to become green university. Solid waste management based on segregation and Recycling will be able to boost students and lecturers to understand how to properly dispose of solid waste and encourage students to love and care for the environment. There is still a large knowledge gap on solid waste management. Therefore, our training hub on "Waste Management through Segregation and Recycling " will be needed.

DESCRIPTION

GOALS

The goal of the training hub is to provide capacity building on solid waste management, including waste management technologies, building research partnership among relevant stakeholders.

The specific objectives are:

1. To provide training services for government institutions, NGOs, communities, private sectors, local people and informal workers on solid waste management;
2. To support curriculum development in waste managements, research and knowledge-sharing platform.
3. To build collaboration on research partnership amongst development partners,

STEPS TAKEN TO START THE TRAINING HUB

To support the current development of higher education, the University of Heng Samrin Thbongkhmum released a 10-year Strategic Plan 2021-2030 based on the development pathway of the government. As stated, the research agenda was not incorporated into the UHST's 10-year strategic plan. Under the implementation of the STEM Education Local Partnership, the university developed a University Research Manual (URM) for approval with a proposed vision, mission, goal, and strategies in order to implement the research management at UHST to support the institution in setting up a research management system to be submitted as a compass for conducting research to supplement on its strategy plan. Based the results of the SWAP project, the university started considering a number of training services such as

- **Research programme areas**
  - Socio-economics of waste collection
  - Promoting the organic component of municipal waste, including food waste
  - Promoting in recycling rate
  - Promoting the 3R concept
- **Capacity building**
  - Training on waste management-related fields to students, academic staff, lecturers, professor, and researcher at higher education
  - Capacity building for relevant government institution, NGOs, community and private sectors in terms of joint project development
  - Seeking and facilitating scholarship for students in the field of solid waste management (SWM) and related fields
  - Consulting, guidance on curriculum, proposal writing, and providing teaching material
  - Organizational capacity affecting SWM
  - Human resource capacity
  - Solid waste management technologies
  - Advocacy and knowledge management
  - Partnership and alliance building capacity
- **Knowledge transfer**
  - Scientific conferences
  - Policy forum
  - National symposium
  - Knowledge sharing events

The following is defined the stakeholders involved with the training hub, including students, farmers, agricultural cooperatives, agricultural communities, NGOs, entrepreneurs, relevant stakeholders and development partners.

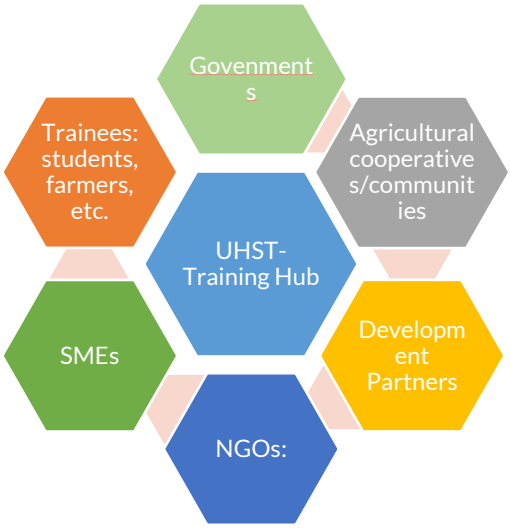


Figure 1: Training/services offered in UHST-Training Hub and relevant partners

Training Hub's Characteristics

The SWAP UHST Training Hub will be a leading hub in research based-learning focused on the three areas: research programmes, capacity building, and knowledge transfer.

Leadership: to be a leader within higher education institutions will play important roles in solid waste management and capacity building engagement and promoting academic institutions to get involved with relevant stakeholders at all levels, NGOs, private sectors, and development partners.

Management: In high-performing research unit, our staff must be qualified and potential people, which having educational background related to PhD. and MSc. in Environmental Science, Climate Change, Natural Resource Management, Agricultural Science, Project Management, and international development studies, particularly experienced and professorial positions, international experience and project-funded implementation.

Research & Development: to be well-performed on R&D, the high-performing research hub prioritise the research areas aligned with the government policies and national strategic development plan (NSDP), where they should be applied to achieve the best results in the areas and support to the development goal with participants from all relevant stakeholders.

Capacity Building: with the high-performing research hub must provide training and mentorship programmes to develop staff, while offering rewards for strong performance. Also, knowledge obtained from training programmes and related-education performance will be shared through training activities under the management of university, executed by its Training Hub.

Social Engagement: Staff within high-performing research units display a distinct ethos of social and ethical values, and they must show their motivation, self-development and society. Promoting cultural exchange among academic institutions locally. In other words, building network with SWAP university partners in the region and the world through development partners, especially the host and the programmes countries will work closely to enlarge cooperation with the areas.

Policy-making: Contribute to the development of the policy makers through research-based results. The governmental institutions may lack of information or data on the gaps when they are implementing the development plans. The Hub will provide the research results to policymaker supporting the decision-making with participant from all levels.

Action Plans: High-performing capacity building of training hub has strategies that are real, living and owned, and more than merely a written document.

Researchers: Enable and encourage researchers to initiate collaborations widely as opposed to using a top down approach. Implementing action plans proposed by the hub in order to find support and development high quality of scientific materials for knowledge transfer.

EQUIPMENT

The equipment of the SWAP training hub is provided by SWAP project funds under the Erasmus+ program. It includes:

No.	*Category*	*Quantity*
1	High-end Laptop	01
2	LCD Projector	01
3	Smart TV (60")	01
4	Home biogas/composter model	04
5	Double shaft Shredder	01
6	Extruder	01
7	Wheel loader	01
8	Screening machine	01
9	Hand Tools including Sorting Table - Tetal Top, Whiteboard, Set of wrenches, Volt meter, Personal protective equipment, Cordles Screwdriver, Set of screwdrivers)	01

STRUCTURE

The UHST Training Hub is working under the direct management of the Faculty of Agriculture of the University of Heng Samrin Thbongkhmum in Thbongkhmum Province. Figure 2 shows its organisation.

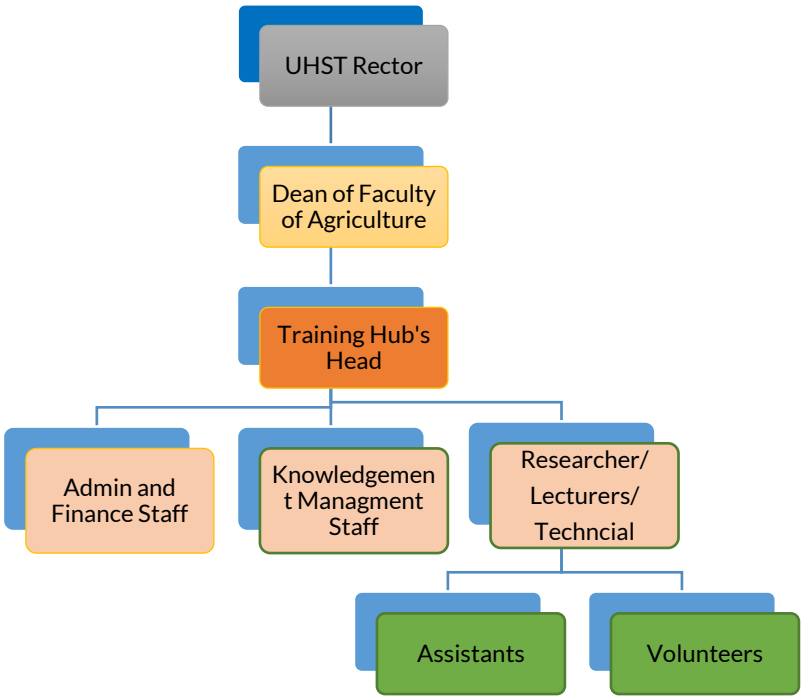


Figure 2: UHST Training Hub's Organizational Chart

The main resource persons for the training hub are as follows:

1. Assoc. Prof. Pin Tara, Vice rector
2. Dr. Hem Lina, Vice dean of faculty of Agriculture for manager of the training hub
3. Ms. Uon Sophal, Head of Department for knowledge management staff
4. Ms. Meas Sreylen, Head of Department for Researcher/Lecturers/Technical
5. Mr. An Theal, Head of Department for technical assistant for compost making
6. Mr. Tim Samnang, lecturer for Researcher/Lecturers/Technical
7. Mr. Sok Pheak, lecturer
8. Ms. Ray Kuy, Assistant for admin and finance staff

ACTIVITIES

Activities started before the official inauguration, to test the functioning of the hub.

- Delivery of Bachelor course "Introduction to sustainable Solid Waste Management and Circular Economy" started in semester 2nd year 2nd (date 13 March 2023-13 August 2023) with 22 students.
- Delivery of TVET course: "Sustainable Solid Waste Management" started in semester 2nd year 2nd (date: 24 - 25 October 2023) with 19 students.
- Organized on "The inauguration of training hub for sustainable solid waste management and Policies-SWAP" (date: 26 - 27 June 2023) with 80 participants. On the morning of June 26, 2023, UHST organized a workshop on "The Inauguration of the Training Hub for Sustainable Solid Waste Management" at the university, Tbong Khmum Province. This 2-day workshop was held in order to 1) understand the general information of the implementation of SWAP project 2) collect input from stakeholders to prepare a business plan for solid waste management 3) and disseminate and launched a training hub for sustainable solid waste management and policy. The workshop was attended by a delegation of EU project partners from Germany, Italy and Greece, Dean and Vice-Dean of faculties, institutes, professors, lecturers and government officials from relevant provincial departments of Tbongkhmum province, as well as students. There were 11 implementing partners, including: Chiang Mai University (CMU) and Maejo University (MJU) in Thailand, Royal University of Agriculture and The Environmental Education and Recycling Organization (COMPOSTED) in Cambodia, Thai Nguyen University of Agriculture and Forestry (TUAF) and Hue University of Agriculture and Forestry (HUAF), Vietnam, as well as European partners (TUHH, IFOA, EuroTraining, POLIBA). Through the SWAP project, the University has established the UHST Training Hub for Solid Waste Management, which aims to provide capacity building on solid waste management, including waste management technology, strengthen research partnerships, and further develop cooperation in effective solid waste management. The project also provides some equipment to implement in this training hubs. All of these activities will contribute to capacity building at the university level and support training activities. Focusing on vulnerable groups of informal waste practitioners, as well as promoting entrepreneurship and employment opportunities of graduates in the field of sustainable waste management, and preparing documents to support relevant policies through providing methods and development of good quality curriculum.
- Dissemination workshop on "Solid Waste Management at in University of Heng Sarin Thbongkhmum" (date: 20 February 2023) with 75 participation.
- SWAP INFO-DAY on Experience sharing on the compost making from earthworm (Date: 04 December 2023) with 45 participants. This event invited Nhoeun Chanreth, General Manager of AGRONature Co., Ltd. It aimed at building capacity of undergraduate students from the Faculty of Agriculture on the compost-making from earthworm at the UHST campus.

- Dissemination on "Solid Waste Management at in University of Heng Sarin Thbongkhmum" during opening day of TVET Student for new academic year (date: 05 December 2023) with 200 students. As of new academic year, 2023-2024, the university offered TVET program by integrated a developed course from SWAP into curriculum at the Institute of Vocational and Professional Training of the university.

POSSIBLE FUTURE COOPERATIONS

In order to ensure sustainability of the SWAP training hub, it's very crucial to seek the external collaborations for fundraising.
Based on the interest from private sector, Agro-Nature Co.., ltd the company will operate in research and training activities in the field agriculture, particularly waste management from agricultural residual.

FINANCIAL STATE OF PLAY

Presently, the training hub has been operated with the financial support from university and SWAP project. After ending the SWAP project, its earnings for the projection for the next 2 to 5 years will get from fees from training activities; consultant and technology transfer services or research projects.

ASSESSMENT SO FAR

What worked well: positive results

- The raising awareness in young generation on solid waste management is one of the most significant activities that we have done well so far. The young generation helps us to disseminate knowledge on solid waste management practices to family members and community.
- The initial collaboration with private enterprises and stakeholders in the framework of SWAP project, we have close cooperation in training and research activities for future work.
- Received the strong support from university leaders to facilitate the SWAP training hub activities to run smoothly.
- Opportunities to start up SME for higher education in term of running compost making

What could have worked better: problems and solutions found

- Improve facilities in laboratory for teaching staff and students to do research and experiments.
- More opportunities for academic staff to improve their capacity in teaching and research.
- Build a networking at local, national and international level to share information on collaboration and resources in the field of solid waste management.
- An engagement of undergraduate students to start up small business with their business during the course implementation.

Our final judgment about this period

In general, the SWAP training hub is the initial base for implementing sustainable solid waste management practices. While operating the SWAP training hub, the challenges and opportunities are always there. However, we hope that the SWAP training hub will be a leading hub in training and research in the field of sustainable solid waste management in Cambodia.

LOOKING AHEAD

What we see positive for the future

The needs of labor market on solid waste management will be high because this is one of the strategies that the government promoting the TVET students to engage in the industrial sector. The diversification of training topics will attract many potential learners.

What we see challenging for the future and possible solutions

- The improvement of community's awareness in sustainable solid waste management is a challenge.
- The sustainability of the SWAP training hub requires a lot of human and financial resources, technical, and time, and the Training Hub may need more equipment and laboratory.

APPENDIX

Figure A1. Theory and practice Bachelors and TVET students

Figure A2. Dissemination workshop in February 2023

Figure A3. The inauguration of the Training Hub

Figure A4. Information day on Experience sharing on the compost making from earthworm on December 4th, 2023

Figure A5. Opening day of TVET Students on 5th December 2023

MAIN FINDINGS AND SWOT ANALYSIS

GENERAL REMARKS

All 6 training hubs planned by the project started their activities in 2023, being the first one inaugurated in March (MJU), and the last one in November (UHST). That was due mainly to the time required by each university to carry out the proper legal, official and practical procedures regarding the establishment of the hubs, to sign contacts with suppliers and to find physical spaces or build structures, to make available and ready the necessary premises.
It is worthwhile highlighting that the concept of "training hub" and the close cooperation with stakeholders other than own management, colleagues and students was an absolute novelty for the universities, as well as approaching TVET, with its peculiarities, methods and target groups. The organisational and methodological effort put in place by all Asian partners for such new implementation has been very high.
Of course, these differences impacted on the number of activities carried out and on the information and data available to assess the functioning, the results and the perspectives of each. However, some common points clearly emerge from the first performance period.

First, all hubs started-up focussing especially on training. This is of course full in line with the nature of the hubs and of the promoting institutions, all being universities. The training programmes, however, were not only targeted to university students, but also to younger learners and to other adults. More, in many cases they have been complemented/integrated by other communication and awareness raising activities.
Second, they are all physically located inside the partner universities/faculties/departments.
Third, all show governance teams directed and composed almost exclusively by university representatives.
Fourth, all exploit equipment purchased thanks to the SWAP project grant.
Fifth, partner universities from the same country (CMU and MJU in Thailand, HUAF and TUAF in Vietnam, RUA and UHST in Cambodia), kept in touch with each other and exchanged information and advice during the set-up of their own hubs, confronting and discussing options and decisions.
Sixth, the EU partners provided for support to all hubs in the start-up phase, especially on the methodological side.

All in all, 15 training, information and awareness raising activities were delivered on the occasion of, or after the official inauguration of each training hub, involving over 1.000 people among university students, VET learners, adults, citizens and informal workers and external stakeholders and decision makers. Others were developed and delivered even before, but are not counted here.
Details are provided for in the following table.

	CMU	*MJU*	*HUAF*	*TUAF*	*RUA*	*UHST*
inauguration date	25.05.23	10.03.23	17.05.23	27.09.23	11.11.23	26.06.23
HR involved	6	8	9	10	11	8
courses delivered	1	2	4	4	1	3
total attendance	11	33	112	532	86	254

Strong points, room for improvement and main findings highlighted by partners in individual reports are synthesized at the next paragraph.

SWOT ANALYSIS

STRENGTHS
(positive factors internal to partner organisations)

S1. All training hubs were successfully established and started-up.
S2. All partners raised their own awareness regarding the relevance of standing out as reference point at regional/national level on the topic characterising their training hub.
S3. All partners improved their ability to share knowledge and expertise, and begun building a network of national and international partners.
S4. All partners have now trained Human Resources on the main topics their hubs deal with.
S5. All partners can exploit up-to-date, tested and internationally developed teaching and learning resources.
S6. All partners can exploit new and up-to-date equipment, to carry out practical activities in their training hubs.
S7. All partners grew a fertile soil for suture development, by raising awareness of external stakeholders.
S8. All partners have a much clearer view of issues, needs and opportunities related to future sustainability of their respective training hubs.

WEAKNESSES
(challenging factors internal to partner organisations)

W1. Despite the length of the project, performance was affected by the Covid-19 pandemic, which caused delays in delivery. Therefore, in order to comply with project provisions, partner focussed somehow more on tasks, rather than on long-term objectives, with the intention of keeping what was promised first, in the meantime starting thinking about a broader perspective. That is why, in these months, training activities (more in line with partners' nature) played the main role, while consultancy and raising awareness were somehow designed, but foreseen for the future.
W2. Some partners still need to develop a full awareness of the meaning and the opportunities offered by a training hub.
W3. Governance is often almost fully internal to partner universities, external stakeholders being involved, so far, more as service providers than as co-players.
W4. Development strategies for the hubs appear as just outlined. This is probably due to the recent establishment of the hubs.
W5. Financial planning is still feeble or missing: funding has been granted by project SWAP and by the involved universities so far, but the first source is now coming to an end, and the second one cannot last indefinitely, so this is a relevant weak point to consider.
W6. More in general, partners leading training hubs seem to clearly see the challenges they will face in the future, but not all solutions appear to be identified and pursued yet.

OPPORTUNITIES
(positive factors external to partner organisations)

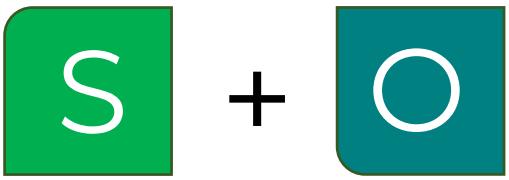
O1. Existence of the national and international network of project partners, and availability to further cooperation.
O2. Permanence of opportunities offered by Erasmus+ Capacity Building projects, and by other EU and national funding channels.
O3. Customer satisfaction of participants in hub activities so far.
O4. Consequent visibility gained through project activities.
O5. Existing market need for training hubs activities, also regarding possible different waste streams, and specific target groups, like learners in TVET courses and informal workers.
O6. Overall favourable moment for initiatives aimed at protecting the environment, fighting the climate change, supporting the "green" transition at the national and international level.

THREATS
(endangering factors external to partner organisations)

T1. At the moment, the networks of external stakeholders appear in most cases not structured nor developed, and hubs are quite self-centered as to governance, human resources and funding.
T2. If the hubs will not carry out activities –other than training– to the benefit of the respective local/national contexts, the financial support will depend only on internal resources, which might not be guaranteed in the long term.
T3. Possible changes in attitude and favour of national governments.

RECOMMENDATIONS AND CONCLUSIONS

By crossing the above-mentioned findings, some recommendations can be drafted as follows.



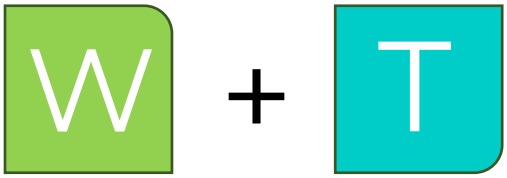
Matching strengths and opportunities can provide for suggestions for improving what already works, and make it excellent. Generally speaking, the point for partners leading a training hub should be "*riding the positive wave*" generated by SWAP to make it last.

The end of the project sets a perfect chance to ***continue and broaden the activities carried out so far***. Partners learnt through the project, had the chance to develop and test new pieces of their training offer, both institutional, "classic", and innovative (like TVET courses), can rely on a brand new on-line supporting platform complete with materials, have been capable to purchase new, efficient, up-to-date equipment. They are therefore now fully in the position to exploit what they build along the project lifespan. At the same time, the context and the market show an increasing demand for learning and training about Solid Waste Management methods, practices and implications. On the political side, too, waste management, and the green transition in general, are high on the agenda at present. Such concurrence of internal and external factors provides for a unique opportunity to boost project achievements and to expand them to new waste streams, new target groups (in this sense, TVET has just opened a door on a potentially huge audience, public and private) and new territories.

An additional catalyst for the future is the ***large visibility and acknowledgement*** gained by the universities through the project. Partners demonstrated a very good capacity of disseminating their progress, thus starting to attract fair numbers of potential users/customers of the training hubs, besides their students and teachers. This is something that should be continued, on the one hand by keeping the effective communication channels exploited so far, on the other by planning and offering more, new opportunities of involvement.

Linked to the previous is the recommendation to exploit the existing knowledge, skills, premises and equipment not only for training purposes, but also to ***start delivering services to the external market***, represented not only by other universities or by schools, but also by public and private companies, associations, public authorities, and individuals (informal workers, interested people, want-to-be entrepreneurs, etc.). Services might of course be in the form of training courses, but could also be seminars (face-to-face or online), workshops, production and sale of goods made also thanks to the machinery available in the hubs (e.g. compost), etc.

One final recommendation regards exploiting all the above in order to ***get further funding***, as improvement requires financial resources, too. Involving University administration or consultancies for funding options, to have feasible cost calculations could be an option. For ~~For~~ sure, now that the Asian and the EU partners have got to know and appreciate each other, the design and ~~possible~~ participation in more funded projects is desirable and possible, not only through Erasmus+ (e.g. Horizon Europe opportunities could be investigated), but also by approaching local and national programmes in Thailand, Vietnam and Cambodia, or considering transferring the good outcomes achieved to other neighbouring countries in South Asia (like Laos, ~~or~~ Indonesia, the Philippines, etc.).
And, the private sector should be seriously considered, in order to increase income and allow for further expansion of the hubs.



At the other end of the string, matching internal weaknesses and external threats can provide for a good risk analysis and led to foresee possible traps and avoid them, or limit the damage they could bring. As a matter of fact, training hubs just started their work, and they still have a potential long road ahead of them, which presents several potential pitfalls. The partners seem to see and understand the forthcoming issues very well: the challenge is now for them to devise and put in practice answers and solutions.

A first recommendation here is ***to boost consensus and commitment inside the partner organisations***. No doubt that the group of teachers involved in SWAP know what training hubs are, participated in activities carried out so far, and devoted time and personal capacity to their establishment and start-up. Now the point is to transform the training hubs into something owned and belonging to the whole partner universities. This would imply not only engaging more teachers or students into courses, but also improving their commitment, by allocating responsibilities, co-creating ideas for the future, co-managing activities. Otherwise, several risks could rise: teachers involved at the moment could for example retire by age, or move to another university, or not be available in the future due to other professional engagements; or, without new, fresh resources, the hubs might continue delivering "standard" courses and lose momentum; that would bring to feeling tasks relating to the hub as extra-load, and to lose attraction and commitment, and, in the end, to the end of the hubs.

Side by side with the previous points goes ***the need to get more and more external stakeholders involved*** (that is, participating) ***and committed*** (that is, participating with passion and wholeheartedly). The establishment of training hubs is still quite recent, and true it is that some of them already started signing agreements with external bodies or companies. Nevertheless, even if for very well understandable and partly justified reasons, the feeling is that the training hubs are at the moment rather an "internal affair" of the partner universities. Yes, the idea was theirs, the first available experts were their professors, it was the universities being able to get and entitled to spend the grant coming from SWAP, and -even more relevant-, it was the universities who put additional money, and premises, and efforts, and material, in order to start the hubs up. That is OK. But the risk is that, once the grant is spent and the project is over, if the results are not sufficient, the universities will reduce and eventually withdraw their support (human resources, material, premises, funding), thus bringing the hubs to a quick shut down. To counter that, one sound option seems to be "reaching out" to external players, who might support universities from many points of view, by avoiding/mitigating possible excessive self-referentiality, by keeping a constant link between the training hubs activities and the market needs, by bringing in potential new ideas, materials, equipment, human resources and funding. As mentioned in the first recommendation, involvement might not be sufficient here, too, and the universities should rather head to getting the external stakeholders committed to their training hubs goals and success, for example signing written agreements of cooperation or memoranda of understanding when possible. By the way, deliverable D4.5 provides for some guidelines about stakeholder engagement and loyalty building.

A third consideration stems directly from the above, and mirrors what has been said when matching strengths and opportunities: almost all training hubs should ***develop*** (or in some cases

should refine and better detail) ***a strategic and financial business plan, concrete and with a set timing***. In other words, they should ***define and follow a precise sustainability plan***.
In particular, regarding financial sustainability, at the moment, out of the 6 training hubs:

- 2 presented some financial projections for the next 5 years; in both cases, the hubs are expected to show, from the very first year, income larger than costs. However, it is worthwhile mentioning that 40% (in one case), and about 65% (in the other case) of income come from university funding; this is of course very positive and shows the will and commitment of these universities to sustain their hub activities; at the same time, should the university contribution come to an end for any reason, the remaining income would not be sufficient to cover the expenditure;
- 3 declared that the university will take care of covering expenditures, but did not provide any figures (so they are possibly incurring at least the same level of risk as the previous ones);
- 1 did not provide any information.

Of course, one mitigating factor is that the hubs are newly established, and that the universities will very likely be keen to support them in the next years. Nevertheless, we would encourage partners to take this aspect into serious account.

As a final word, we believe it is important to acknowledge the huge work carried out by all partners in the design, development and start-up of the training hubs. They had to get familiar with concepts, strategies and terms that were perhaps “normal” for the EU partners. They had to convince their management of the relevance of setting up the hubs, and of the validity of the investment. They had then to physically carry out all the related work, for structures, infrastructures, equipment, staff preparation, event planning, organisation and delivery, communication, etc.
At the end of the SWAP path, the common assessment is that a very good foundation and start have been put in place, which of course will now have to stand and walk on their own feet.