
# SUstainable developmeNT Smart Agriculture Capacity « SUNSpace »

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# Contents

## List of Tables



## List of Figures

# 1. Literature review

## *1.1. Kirkpatrick*

Training Evaluation to ensure whether the training program has successfully reached the objective, an evaluation is needed. Kirkpatrick (in National Weather Service Training Centre, 2007), stated that training evaluation is the process of information and data collection systematically. This training evaluation ought to be planned along with the training plan, based on the planning of objectives and goals the company wanted to achieve. In our project, the evaluation is meant to obtain information about the training program results. Training evaluation later results in feedback, including the reaction of the participants, learning results of the participants, behavioural changes of the participants in the workplace, and results obtained (Kirkpatrick, 1998).

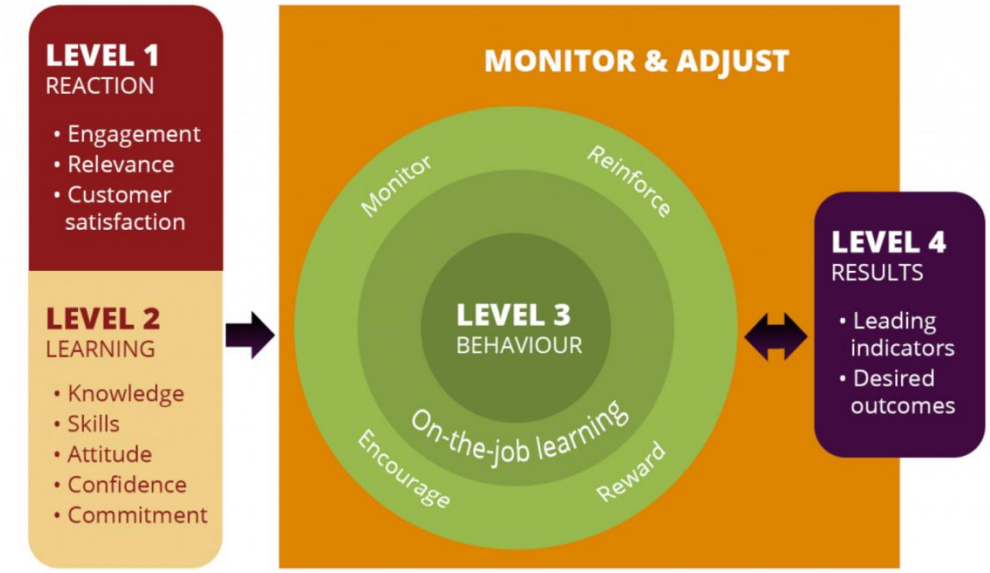


**Figure 1**: Level of Kirkpatrick Model

Kirkpatrick's employs a Four Levels Training Evaluation Model in general (see Figure 1). There are numerous methods for evaluating training, also known as training evaluation methods, that can be used in a company. The method used in this study is Donald Kirkpatrick's (1998) Kirkpatrick 4 Levels, which are as follows:

**Level 1**: Reaction This level measures how the trainees or the participants of the training reacted to the training. It is important to measure reactions, because it may help to understand how well the training was received by the participants. It also helps to improve the training for future trainees, including identifying important areas or topics that are missing from the training.

**Level 2**: Learning This level measures what the participants have learned. When planning the training session, it is normally started with a list of specific learning objectives, which can be the starting point of the measurement. It is important to measure this level, because knowing what the participants are learning and what they are not learning will help to improve future training.

**Level 3**: Behaviour This level will evaluate how far the participants have changed their behaviour, based on the training they received. It is important to realize that behaviour can only change if conditions are favourable. So this stage is best measured after the two levels above are done. However, just because behaviour has not changed, doesn't mean that the participants have not learned anything.

**Level 4**: Results This level will examine the training's final results. This includes outcomes determined by the company to be good for business, good for employees, or good for the bottom line.

### *1.2. Maturity model*

In the context of software development, the maturity of an organisation's capability to develop software may be defined as the ability of an organisation to "repeatedly and reliably deliver customers' requests" (Poppendieck, 2003) or the extent to which an organisation has established the processes to repeatedly develop high quality software to meet the customer's requirements on budget and on time. Maturity in this context relates to the organisation and its institutionalization of the processes (Chrissis et al., 2003).

The Concise Oxford Dictionary (Allen R E, 1990) defines mature as

1. An Adult with fully developed powers of body and mind
2. complete in natural development, ripe
3. duly and adequate.

In an educational context, learning maturity may be defined as the extent to which a person has developed their capability to repeatedly and reliably achieve learning outcomes that involve the ability to apply, critique, analyse, reflect, and hypothesise on the subject under study. In terms of the dictionary definition, a mature learner will have fully developed powers of learning, where powers of learning may be defined as the cognitive and metacognitive skills (Bloom et al., 1956) that characterise deep and critically reflective approaches to learning (Biggs, 1999; Biggs and Collis, 1982). The mature learner accepts changes to their perspective on learning and on the subject matter (Mezirow, 1991) and commits to their current understanding based on sound reasoning (King and Kitchner, 1994; Perry Jr., 1968; Polanyi, 1958) and the processes of the subject area (Costa and Liebmann, 1996).

Identifying whether a learner is using deep, achieving or surface strategies is inadequate to determine learning maturity (Biggs and Collis, 1982; Hunt, 1995), since the selection of a learning strategy relates to the learner's task representation rather than to the characteristics of the learner (Hunt, 1995). Even in a task representation that may involve the characteristics of a deep approach to learning, the learner may initially utilise surface strategies to build a knowledge base before endeavouring to utilise the strategies of deep approaches to learning. There is sequencing in the use of strategies depending on the learner's prior knowledge and the learning task at hand. A mature learner is able to select appropriate strategies based on their prior knowledge and the learning task representation. Furthermore, prior knowledge has been identified as a key factor in learning success (Hunt, 1995). Bransford et al. (Bransford et al., 2000) emphasise the need to "draw out and work

with the pre-existing understandings that their students bring with them". In the context of a process model for learning, we would expect to see a mature learner's learning process identify learning strategies that will identify relevant pre-existing understandings and knowledge and connect the current learning with these prior understandings and knowledge. In the project, the maturity model has been conducted along with the assessment model. The main objective is to measure the maturity level of participants. Therefore, the pre-training level has been created and added to the Kirkpatrick assessment model.

### *1.3. Bloom's Taxonomy*

Bloom's Taxonomy Benjamin Bloom, together with his colleagues, came up with a system called Bloom's Taxonomy of Educational Objectives where categories were formulated for cognitive (thinking and problem solving skills), affective (attitudes) and psychomotor domains (Bloom et al. 1979). It is important to note that the most common usage of Bloom's taxonomy focuses on cognitive learning skills rather than psychomotor or affective skills (Adams 2015). This is confirmed in Bloom's research (Bloom, Krathwohl, and Masia, 1971), in which most learning objectives fell into the cognitive domain, followed by the affective and psychomotor. The cognitive classification can be described as "thinking head", meaning that it involves activities that stimulate the mind, while the affective domain can be thought of as the "feeling/heart" (emotion) and the psychomotor domain as "doing/hands" (physical) (Weigel and Bonica 2014).

Bloom's taxonomy is formed from simple to more complex, easy to more difficult, concrete to abstract, and as a prerequisite to each other (Tarman and Kuran 2015). The categories are arranged in a cumulative hierarchical framework-achievement of the next more complex skill, or ability required for achievement of the prior one (Krathwohl 2002). Therefore, only after knowing a certain subject, may the student apply it. The taxonomy is not just a scheme of classification, but a possibility of hierarchical organization of cognitive processes according to levels of complexity and development of cognitively expected objectives.

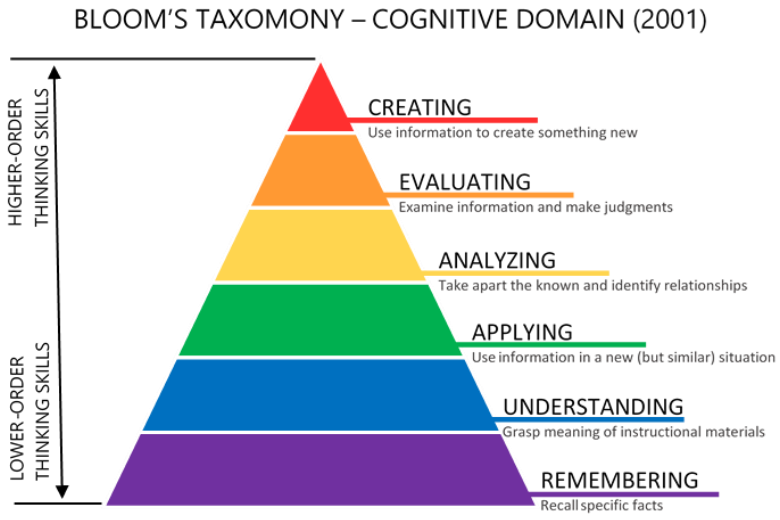


**Figure 2**: Bloom's Taxonomy/ *Retrieved from https://educationaltechnology.net/blooms-taxonomy/*

There are six categories in the original Bloom's taxonomy. Knowledge is the foundational cognitive skill and refers to the retention of specific, discrete pieces of information, such as facts and definitions. Comprehension requires more cognitive processing than simply remembering information, and learning objectives that address comprehension will help learners begin to incorporate knowledge into their existing cognitive schemas. This allows learners to use knowledge, skills, or techniques in new situations through application. Distinguishing between fact and opinion and identifying the claims upon which an argument is built requires analysis. Evaluation is important for critical thinking. Critically appraising the validity of a study and judging the relevance of its results for application to a specific business situation also requires evaluative skills (Adams 2015).

Based on the findings of cognitive science following the original publication, a later revision of the taxonomy changed the nomenclature and order of the cognitive processes of the original version. The levels are now; remember, understand, apply, analyze, evaluate, and create. This revision specifies the four types of knowledge that might be addressed by a learning activity: factual (terminology and discrete facts); conceptual (categories, theories, principles, and models); procedural (knowledge of a technique, process, or methodology); and metacognitive (including self-assessment, ability, and knowledge of various learning skills and techniques) (Adams 2015).

### *1.4. Knowledge Utilization*

Knowledge is said to be utilised if it is applied in real-life situations (Gold, Malhotra, & Segars, 2001). For example, expert knowledge from various project team members is used when developing innovative solutions to manage on-site problems (Chen & Mohamed, 2010). Knowledge utilisation is also perceived to have a learning component and overlaps with the knowledge development process (Kalling, 2003). Utilisation of tacit and explicit knowledge by means of knowledge management tools and techniques is observed to be significant to the improvement of project management in various industries (Lierni, 2004). Knowledge utilisation is vital in the management of projects as it relates to performance improvement, increased productivity, and capability enhancement. Chen and Mohamed (2010) claimed that knowledge utilisation could lead to the production of output which has a significant impact on business performance. Davenport and Klahr (1998) stated that knowledge utilisation could improve companies' efficiency and reduce their costs. Knowledge utilisation is observed to result in modified and improved activities, like improving efficiency when performing tasks (Kalling, 2003). In the construction sector, Chen and Mohamed (2010) affirmed that knowledge utilisation is significant to organisational business performance improvement, achieved through higher organisational productivity resulting from construction techniques enhancement and project cost reduction.

## 2. SUNSpACe Training Assessment Model

### *2.1. The purposes of evaluation model*

The purpose of this evaluation is to understand the effectiveness of the SUNSpACe training course and the improvement of the skills of the farmers. The Kirkpatrick model was proposed for the project. This model will be used to analyse and evaluate the results of the SUNSpACe project in order to assure the quality of training. The model comprises of four (4) levels of assessment as follows.

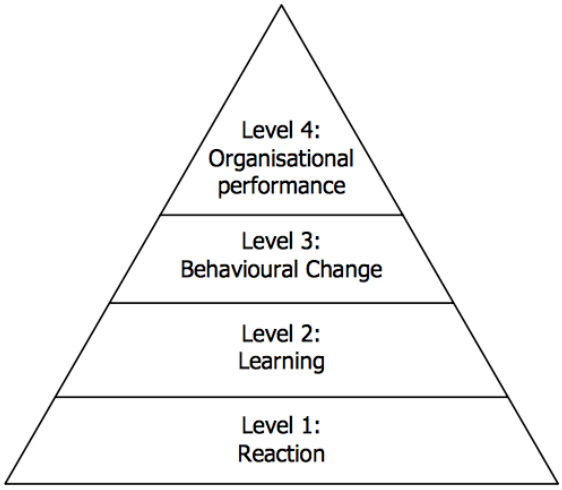


**Figure 3**: Kirkpatrick Model (Ref: Kirkpatrick, 1996)

- Level 1 Reaction: measures how participants react to the training (e.g., satisfaction)
- Level 2 Learning: analyses if they truly understood the training (e.g., increase in knowledge)
- Level 3 Behaviour: looks as if they are utilizing what they learned at work (e.g., change in behaviours)
- Level 4 Results: determines if the material had a positive impact on the business / organization

In an attempt to match with the project's quality assurance, the model has been customized as shown in Table 2.

**Table 1**: Matching Kirkpatrick model and SUNSpACe project

| Level | Kirkpatrick Model | SUNSpACe Project | Definition |
|---|---|---|---|
| 1 | Reaction | Satisfaction | It evaluates how learners react to the learning activities. |
| 2 | Learning | Knowledge | Measuring the level that learners have developed in expertise, knowledge-skills, or mindset. |
| 3 | Behavioral Change | Utilization | Assessing the change makes it possible to figure out if the knowledge, mindset, or skills the program taught are being used the workplace. |
| 4 | Organizational Performance | Outcome | The overall success of the training model by measuring factors such as lowered spending, higher returns on investments, improved quality of products, less accidents in the workplace |

### 2.2. The proposed of evaluation model

The Kirkpatrick Model is a popular approach to evaluating training programs. However, despite the model focusing on training programs specifically, it's broad enough to encompass any type of program evaluation. The model was improved to match the requirements of the project's output and outcome. The Pre-Training layer was added to check the knowledge of the learners before being trained in order to assess the knowledge maturity of the learners. Moreover, the Bloom's Taxonomy was adopted in the model to classify the level of knowledge, i.e. remembering, understanding, applying, etc.

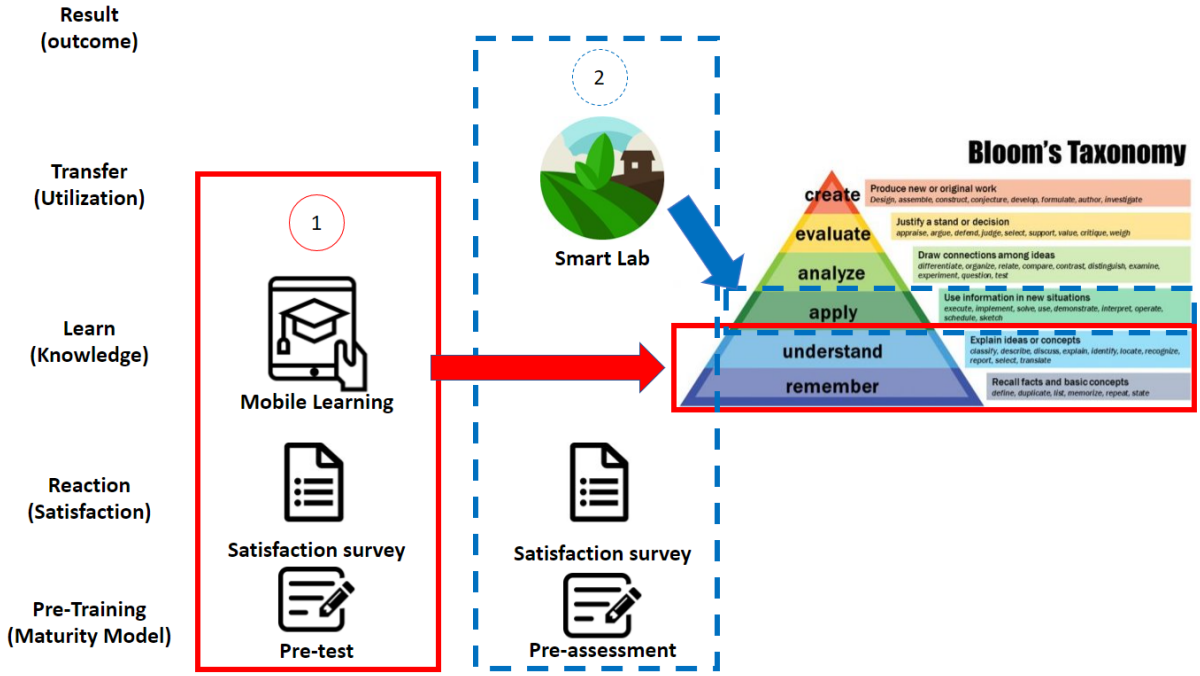


**Figure 4**: Kirkpatrick with Bloom's Taxonomy

In order to materialize the SUNSpACe assessment model, several assessment methods and forms have been developed in the project. The assessment method was divided into 3 venues, i.e. (1) on the mobile learning platform, (2) at the smart farm lab, and (3) at the learners' farm. The form and venue matrix are shown in the figure below.

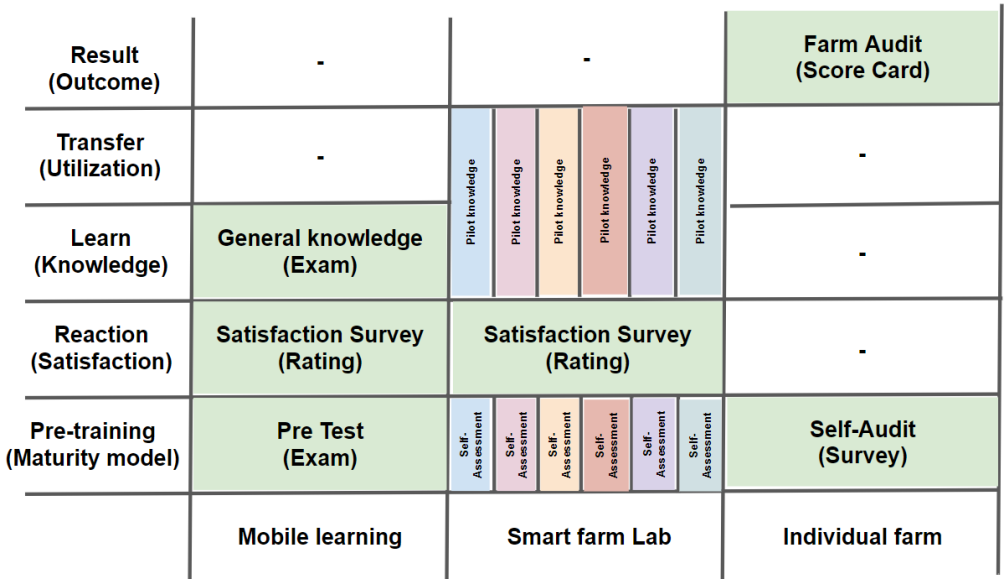


**Figure 5**: Evaluation Plan using Kirkpatrick Model

The procedure to validate the assessment method was developed in order to guarantee that the methods, forms, and content that were developed in the project are applicable in the training. The procedure included 6 steps, as follows.

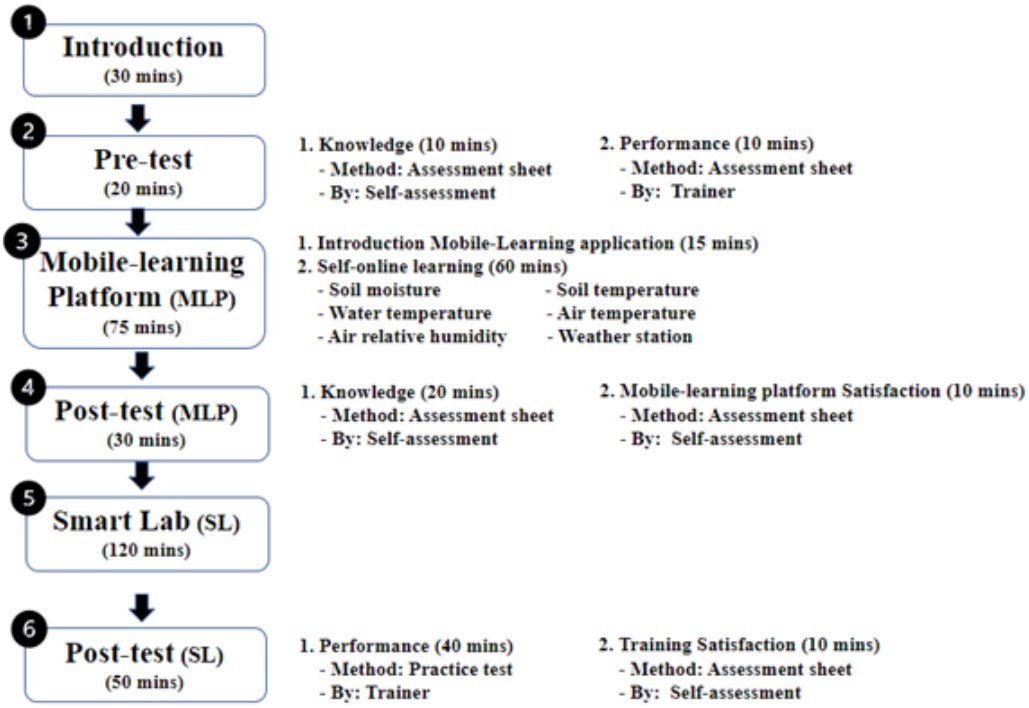


**Figure 6**: The procedure

## 3. Satisfaction and Assessment Methods

Before the creation of satisfaction and assessment surveys, each ASEAN partner (CMU, KKU, AEC, KEC, and RUB) had to define the outcomes of their pilot (see Table 1).

**Table 2**: Pilot project outcomes

| Project Outcome | Criteria | Description | Result |
|---|---|---|---|
| Productivity | Quantity | The smart farming system/technology helps farmers to increase the quantity of yields. | □ Increase the quantity of yields [RS-PQT1]<br>□ Reduce the loss of yields [RS-PQT2]<br>□ Increase average daily gain [RS-PQT3]<br>□ Other ..... |
| | Quality | The smart farming system/technology helps farmers for enhancement of the quality of yield, to get better quality of yields. | □ Increase the sweetness [RS-PQL1]<br>□ Increase the size of products [RS-PQL2]<br>□ No dark spot of products [RS-PQL3]<br>□ Other..... |
| Management | Cost | The smart farming system/technology helps farmers to less spend money for agricultural production. | □ Reduce labour cost [RS-MCS1]<br>□ Reduce infrastructure cost [RS-MCS2]<br>□ Reduce fixed cost [RS-MCS3]<br>□ Other ..... |
| | Input | The smart farming system/technology helps farmers to use less amount of input for caring agricultural products that will help to reduce the contamination of chemicals in agricultural products. | □ Reduce the use of water for irrigation [RS-MIP1]<br>□ Reduce the use of chemical substances [RS-MIP2]<br>□ Reduce the use of fertilizer [RS-MIP3]<br>□ Other ..... |
| | Processes | The smart farming system/technology helps farmers to improve their farm management processes during agricultural production. | □ Improving farm production processes [RS-MPC1]<br>□ Adoption of smart technology for precision farming [RS-MPC2]<br>□ Adoption of machines for farming instead of human labour [RS-MPC3]<br>□ Other ..... |
| Environmental Impacts | CO2 | The smart farming system/technology helps farmers to reduce the CO2 contamination in the air that might impact the environment and the growth of agricultural products. | □ Reduction in CO2 emissions [RS-ECO1]<br>□ Other..... |
| | Chemical | The smart farming system/technology helps farmers to manage the chemical in the environment. | □ Chemical contamination in soil [RS-ECM1]<br>□ Chemical contamination in water [RS-ECM2]<br>□ Other..... |

Table 1 describes the pilot project outcomes. These outcomes are defined based on the smart farming criteria (Arun Khatri-Chhetri, et al., 2017; Chris Clayton, 2018; Jess Rudnick; GMO; DOAE) comprising:

1. *Productivity*: This includes criteria for quantity and quality of products.
    a. *Quantity*: It aims to adopt smart farm technologies to increase the number of agricultural yields to meet the market's demand. The results consist of increasing the quantity of yield (RS-PQT1), reducing the loss of yield (RS-PQT2), increasing average daily gain (RS-PQT3), and other results that may meet the requirements of farmers in the pilot of each partner country.
    b. *Quality*: It aims to adopt smart farm technologies to improve the quality of yields to meet the market's requirements. The results consist of increasing the sweetness (RS-PQL1), increasing the size of products (RS-PLQ2), no dark spots on products (RS-PLQ3), and other results that may meet the requirements of farmers and the market of each partner country.
2. *Management*: This includes criteria for production cost, input usage efficiency, and farm process management.
    a. *Cost*: *It aims* to adopt smart farm technologies to reduce the production costs. The results consist of reducing labour costs (RS-MCS1), reducing infrastructure costs (RS-MCS2), reducing fixed costs (RS-MCS3), and other results that may meet the requirements of farmers in the pilot of each partner country.
    b. *Input*: It aims to adopt smart farm technologies to manage and reduce the amount of inputs (water, fertilizer, chemical substances) used for production. The results consist of reducing the use of water for irrigation (RS-MIP1), reducing the use of chemical substances (RS-MIP2), reducing the use of fertilizer (RS-MIP3), and other results that may meet the requirements of farmers in the pilot of each partner country.

c. *Processes*: It aims to adopt smart farm technologies to improve the processes of agricultural production and farm management. The results consist of improving farm production processes (RS-MPC1), adoption of smart technology for precision farming (RS-MPC2), adoption of machines for farming instead of human labour (RS-MPC3), and other results that may meet the needs of farmers in the pilot of each partner country.

3. *Environmental Impacts*: This includes criteria for CO2 emission reduction, and chemical contamination reduction.
   a. *CO2*: The aim is to adopt smart farm technologies to manage and control production practices and processes to reduce CO2 emissions in the air. This will decrease the impact on the environment and the growth of agricultural products. The results consist of a reduction in CO2 emissions (RS-ECO1), and other results that may meet the requirements of farmers in the pilot of each partner country.
   b. *Chemical*: It aims to adopt smart farm technologies to manage and control chemical contamination in the environment, which impacts on chemical contamination on productivity. The results consist of chemical contamination in soil (RS-ECM1), chemical contamination in water (RS-ECM2), and other results that may meet the requirements of farmers in the pilot of each partner country.

After defining and selecting the outcome (s) and results, the results measurement has to be defined and filled in the result management template (see Annex 1) with the results description and scoring criteria to evaluate the farm audit of learners (farmers).

According to the Kirkpatrick model explained above, we proposed pre and post assessment sheets and a satisfaction survey to evaluate trainees' knowledge skills and our training course as shown in Table 2.

**Table 3**: List of Satisfaction and Assessment sheets

| Level of Kirkpatrick model | Survey Code | Survey name | Area of learning |
|---|---|---|---|
| Pre-training | TQA-PT1 | Pre-test | Mobile Learning |
| | TQA-PT2.xxxx | Pre-assessment | Smart Farm Lab |
| | TQA-PT3.xxxx | Self-audit | Individual farm |
| Reaction | TQA-RA1 | Satisfaction Survey | Mobile Learning |
| | TQA-RA2 | Satisfaction Survey | Smart Farm Lab |
| Learn | TQA-LE1 | General Knowledge | Mobile Learning |
| Transfer | TQA-TF1.xxxx | Pilot Knowledge | Smart Farm Lab |
| Result | TQA-RS1.xxxx | Farm Audit | Individual farm |

### *3.1. Pre-Training Assessment Method*

The Pre-test of knowledge skills evaluates the cultivation knowledge skills of farmers before they participate in our training course. There are three assessments that farmers have to do before learning on our training course.

### 3.1.1. TQA-PT1 (see Annex 2)

This assessment will evaluate the knowledge and skills of farmers before they learn by using our mobile learning platform. This assessment is the self-assessment sheet that trainees (farmers) have to do before training starts. This assessment sheet has multiple choices. We will analyse farmers' knowledge skills by scoring the correct answers that they have given.

### 3.1.2. TQA-PT2.xxxx (see Annex 3)

This assessment will evaluate the performance of farmers relevant to smart farm technology adoption skills and experience before learning and practicing in our smart farm lab. Farmers will be evaluated by trainers using this assessment before training starts. This assessment sheet consists of questions relevant to smart farm adoption performance that are evaluated by answering 'YES' or 'NO'. We will analyse the farmer's performance on a scoring scale. We will assume number 0 to represent 'NO' and number 1 to represent 'YES'.

### 3.1.3.TQA-PT3.xxxx (see Annex 4)

This assessment will evaluate the farm audits of farmers before they learn and practice from our training course. Farmers have to do a self-farm audit using this assessment before training starts. This assessment sheet consists of the questions relevant to farm audit based on the outcomes of each pilot country.

## 3.2. Reaction Assessment Method

The assessment evaluates the satisfaction of farmers after using our mobile learning platform and workshop in our smart farm lab. There are two assessments that farmers have to do after learning from our training course.

### 3.2.1. TQA-RA1 (see Annex 5)

This assessment will evaluate the satisfaction of farmers after using our mobile learning platform. Farmers need to give the rate of their satisfaction on the assessment sheet. We will analyse by using the Linkert scale. We will assume number 1 to represent 'Very Poor', number 1 to represent 'Poor', number 3 to represent 'Average', number 4 to represent 'Good', and number 5 to represent 'Excellent'.

### 3.2.2. TQA-RA2 (see Annex 6)

This assessment will evaluate the satisfaction of farmers after learning from our smart farm lab. Farmers need to give the rate of their satisfaction on the assessment sheet. We will analyse by suing the Linkert scale. We will assume number 1 to represent 'Very Poor', number 1 to represent 'Poor', number 3 to represent 'Average', number 4 to represent 'Good', and number 5 to represent 'Excellent'.

### 3.3. Learn Assessment Method

The assessment evaluates the knowledge skills of farmers after participating our training course.

#### 3.3.1. TQA-LE1 (see Annex 7)

This assessment will evaluate the knowledge skills of farmers after learning by using our mobile learning platform. This assessment is the self-assessment sheet that trainees (Farmers) have to do it when the training is finished. This assessment sheet is the multiple choices. We will analyse farmer's knowledge skills from scoring of the correct answers that they have done via mobile learning platform.

### 3.4. Knowledge Transfer Assessment Method

The assessment evaluates the performance of farmers after participating and practice from our smart farm lab.

#### 3.4.1. TQA-TF1.xxxx (see Annex 8)

This assessment will evaluate the performance of farmers relevant to smart farm technology adoption skills and experience after learning and practicing in our smart farm lab. Farmers will be evaluated by trainers using this assessment after training starts. This assessment sheet consists of questions relevant to smart farm adoption performance that are evaluated by answering 'YES' or 'NO'. We will analyse the farmer's performance on a scoring scale. We will assume number 0 to represent 'NO' and number 1 to represent 'YES'.

### 3.5. Result/Outcome Assessment Method

This assessment will evaluate the farm audits of farmers after learning and practicing from our training course.

#### 3.5.1. TQA-RS1.xxxx (see Annex 9)

The trainer team will visit a farmer's farm to evaluate the results of applying knowledge of farmers after participating in our training course. This assessment sheet consists of the questions relevant to farm audit based on the outcomes of each pilot country. We will analyse this assessment by using a scoring scale.

## 4. Pilot and Results

### 4.1. Pilot case: Training in Chiang Mai, Thailand Smart Monitoring and Control (29th September 2020)

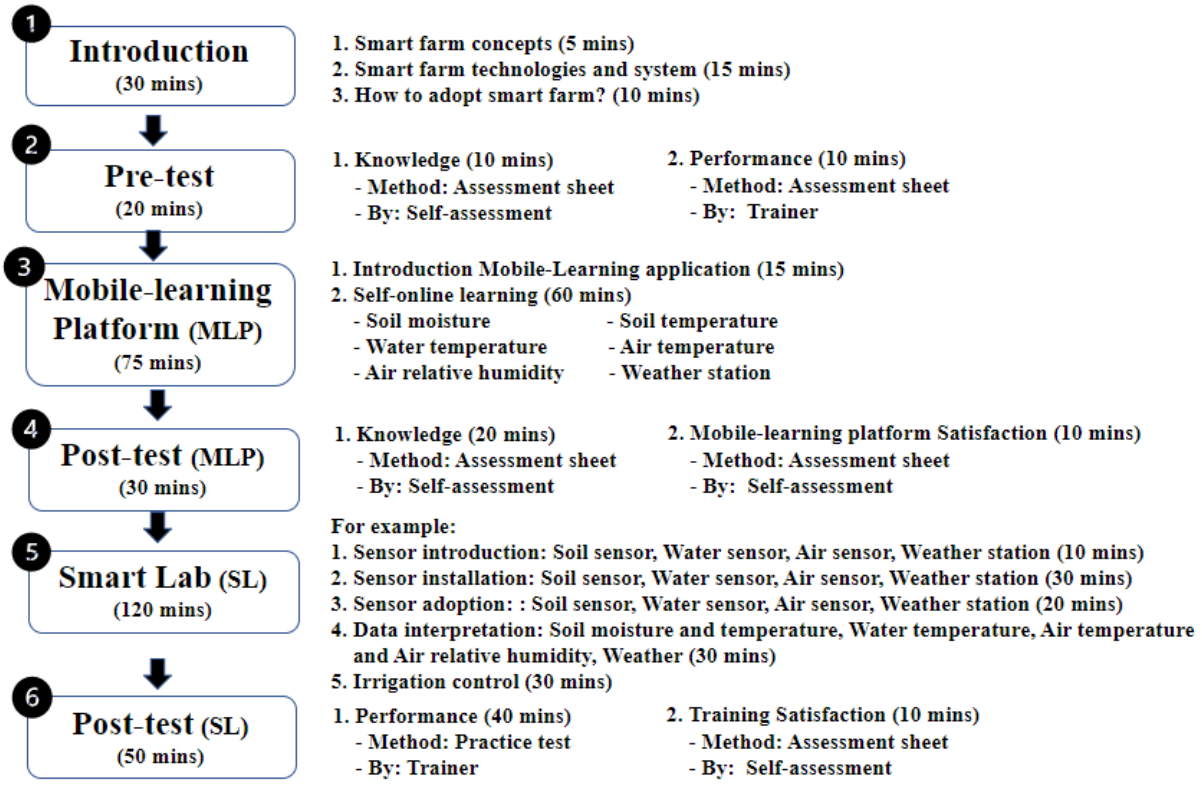


**Figure 7**: The training procedure

Figure 7 shows the training procedure organized in Chiang Mai, Thailand. Our training method begins with the introduction of smart farm concepts, smart farm technology and systems consisting of several aspects, e.g., sensors, devices, software platforms, etc. After that, we explain how smart farm technology can be adapted to the lives of farmers. Secondly, the Pre-Test, where we test the knowledge of the farmers by giving them an assessment sheet to see how much they know. We also test the performance of the farmers by giving them another assessment sheet, this time monitored by a qualified trainer. Thirdly, we have a mobile-learning platform (MLP). The introduction explains how farmers can sign up and use the mobile learning application by following the easy steps, followed by self-online learning which teaches farmers about soil moisture, soil temperature, water temperature, air temperature, air relative humidity, and weather station. Fourthly, farmers need to take a post-test to test their knowledge after learning from the mobile learning platform, and farmers need to provide feedback on their experience after using the application. Fifthly, farmers will have to come to the smart lab to study and practice all about sensors. Finally, we will give farmers a final post-test to check their performance after they have taken our course, which will be monitored by a qualified trainer. Finally, farmers will have to fill out a training satisfaction assessment sheet for us to get accurate feedback on their experience.

### *4.1.1. Farmer's knowledge assessment*

This form is to evaluate the knowledge of the farmer relevant to irrigation management before attending the workshop.

Assessment Code TQA-PT1

Tester Code .....

## Pre Test

**1. What is the meaning of soil moisture?**

A. The amount of water that soil particles accumulate allows water penetration into the soil to stay in the cavity of the soil.

B. The climate of each region and season is affected by soil temperature.

C. The loss of water by evaporation from the surface of the soil and from plant suction.

D. A. and C.

**2. If the soil moisture is too poor, what are the plant's symptoms?**

A. Stunted, slow growing plants.

B. Leaves burned

C. Withered trees, dry plants

D. A. B. and C.

**3. Which is the method for increasing soil moisture?**

A. Drip irrigation

B. Water spray

C. Tillage

D. A. and B.

**4. How does soil temperature affect plant growth?**

A. Affect various reactions in the soil

B. Affect the dissolution of nutrients from plants in the soil.

C. Affect the activities of microorganisms

D. A. B. and C.

**5. What is the appropriate soil temperature for plant roots to grow?**

A. 20 degrees Fahrenheit or -6.67 degrees Celsius

B. 40 degrees Fahrenheit or 4.44 degrees Celsius

C. 60 degrees Fahrenheit or 15.5 degrees Celsius

D. 85 degrees Fahrenheit or 30 degrees Celsius

**6. Which factors most affect the temperature of the soil?**

A. Climate

B. Geography

C. PH value

D. Wind

**7. How many types of air temperature are there?**

A. 2 types

B. 3 types

C. 4 types

D. 5 types

**8. What is the impact of high temperatures on plant growth?**

A. Cell division

B. The development of plant pollen

C. Water and food transport in plants

D. A. B. and C.

**9. In growing plants, what is the high temperature solution?**

A. Cover with the straw

B. Drip irrigation

C. Sprinkle system

D. A. B. and C.

**10. What does relative moisture mean?**

A. The quantity of the water vapor mass in the saturated air as a proportion of the steam mass.

B. The average of the mass of the real vapor of water in the air to that of the vapor of water in the saturated air.

C. The ratio of the water vapor mass in moist air to the actual water vapor mass in the air.

D. The actual water vapor mass in the air as a percentage of the saturated water vapor mass.

**11. Which equipment is used for measuring relative humidity?**

A. Thermometer

B. Barometer

C. Hygrometer

D. Anemometer

**12. In which time does the highest relative humidity average occur?**

A. In the morning

B. In the afternoon

C. In the evening

D. A. B. and C.

**13. What is the appropriate wind speed for plants?**

A. 2 kilometers/hour

B. 3 kilometers/hour

C. 4 kilometers/hour

D. 5 kilometers/hour

**14. Which choice is not the benefit of weather forecasting?**

A. Agriculture and Environment

B. Disaster prevention and mitigation

C. Manufacture of fertilizers and chemicals

D. Transportation by air, ground and sea

**15. Which equipment is used for measuring pressure in the atmosphere?**

A. Anemometer

B. Barometer

C. Hygrometer

D. Thermometer

**16. What process is related to water temperature?**

A. Photosynthesis

B. Cell Division

C. Evaporation

D. A. B. and C.

**17. Which factor is not affected by water temperature?**

A. Metabolic rate and photosynthesis

B. Light intensity

C. Conductivity and dissolved salt

D. Concentration of dissolved oxygen and gases in water

**18. Which choice is incorrect about water temperature sensor?**

A. The sensor is used for water temperature measurements.

B. The sensor can used to link the irrigation system

C. The sensor is used to measure the coolant temperature.

D. It is a device that helps to save water.

### *4.1.2. Farmer's performance assessment*

This form is to evaluate the performance of the farmer relevant to the adoption of smart irrigation technology for irrigation management before attending the workshop.

**Please place a check mark to determine your level of competence in managing water usage in agricultural parcels**

| Code | Result | Activities | Mark | |
|---|---|---|---|---|
| | | | Yes | No |
| RS-MIP1 | Reducing the amount of water used in agricultural plots. | 1. The ability to install a soil sensor device | | |
| | | 2. The ability to install an air sensor device | | |
| | | 3. The ability to take readings from the soil sensor | | |
| | | 4. The ability to take readings from the air sensor. | | |
| | | 5. The Ability to control and manage agricultural plots With a sensor system | | |
| | | 6. How many queues of water is being used in your agricultural plot per month? (Specified in numbers) | | |

**Suggestion**

.....

### 4.1.3. Mobile learning platform Satisfaction

**Mobile Learning Platform Satisfaction Survey**

**Level of satisfaction**
5 = Excellent 4 = Good 3 = Average 2 = Poor 1 = Very poor

**Please check the cross mark on each object in the level value box.**

| Items | Satisfaction Level | | | | |
|---|---|---|---|---|---|
| | 5 | 4 | 3 | 2 | 1 |
| 1. Through the application, users can easily respond to questions. | | | | | |
| 2. The application can be used easily and uncomplicated. | | | | | |
| 3. Users do not have any problems while using the application | | | | | |
| 4. Users can access the application anytime | | | | | |
| 5. Users can communicate smoothly with the app. | | | | | |
| 6. When using the program, users have no internet problems | | | | | |
| 7. Pictures, texts, and sounds are clear and visible in the mobile application. | | | | | |
| 8. The information is interesting and can be repeatedly learned. | | | | | |
| 9. The information is appropriate for teaching and learning. | | | | | |
| 10. Mobile learning gives users the flexibility to use it at all times. | | | | | |
| 11. Online learning saves users time via a mobile phone. | | | | | |
| 12. Online learning via mobile phone gives users the opportunity to get information faster from the classroom. | | | | | |

**Suggestion**

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### 4.1.4. Training/Workshop satisfaction

**The Smart Farm Laboratory Training Activity Satisfaction Assessment Form**

**Level of Satisfaction**
5 = Excellent 4 = Good 3 = Average 2 = Poor 1 = Very Poor

**Please place a check mark to determine your level of competence in managing water usage in agricultural parcels**

| Items | Satisfaction Level | | | | |
|---|---|---|---|---|---|
| | 5 | 4 | 3 | 2 | 1 |
| 1. Quality of training | | | | | |
| 2. The appropriateness of training arrangements | | | | | |
| 3. Online teaching and learning material is suitable and applicable | | | | | |
| 4. Training can completely fulfill the knowledge learners' needs. | | | | | |
| 5. Training period is appropriate | | | | | |
| 6. Overall satisfaction to the training | | | | | |

**Suggestion**

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### *4.2. Results*

#### *4.2.1. Demographic of Farmers (trainees)*

**Table 4**: Demographic of participants

| Participant | Gender | Age | Education | Farm Experience |
|---|---|---|---|---|
| FM-001 | Female | 58 | **Bachelor** | 3 |
| FM-002 | Male | 30 | **Bachelor** | 3 |
| FM-003 | Male | 60 | **Bachelor** | 3 |
| FM-004 | Male | 55 | **Bachelor** | 10 |
| FM-005 | Male | 32 | **Bachelor** | 3 |
| FM-006 | Female | 38 | **Bachelor** | 2 |
| FM-007 | Male | 42 | **Bachelor** | 1.5 |
| FM-008 | Male | 40 | **Bachelor** | 5 |

**Average Age:** 44 years old
**Participants:** Female (25%) Male (75%)

Table 2 illustrates the demographics of participants who joined the training course organized in Chiang Mai, Thailand. There were a total of 8 participants, consisting of 2 females and 6 males, aged between 30 years and 60 years. Each participant is qualified with a Bachelor's degree and has experience of 1 and a half years to 10 years.

### 4.2.2. Farmer's Knowledge

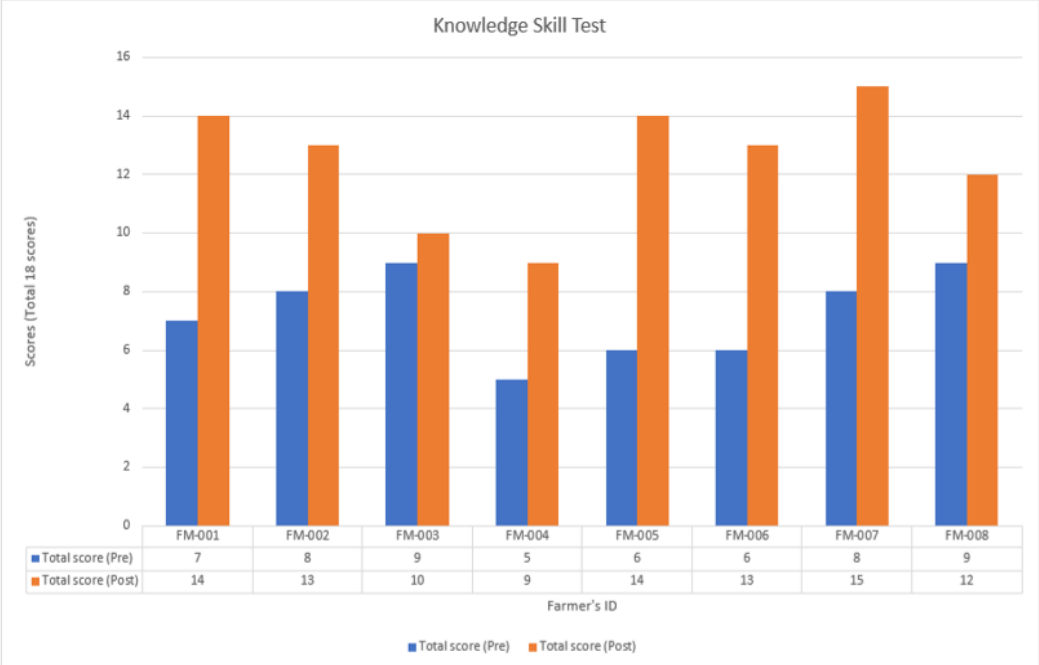



**Figure 8**: Comparison results of farmer's knowledge

Figure 8 shows the comparison results of farmers' knowledge before and after participating in our training course. The blue colour is the result of a farmer's knowledge before attending our training course, and the orange colour is the result of a farmer's knowledge after attending our training course. Based on the results, the knowledge of all participants has improved. However, the level of progress is different because some participants have low or high progress levels (see Figure 9 and Figure 10). According to Table 2, the age of participants in FM-001, FM-003, and FM-004 is over 55 years old, which may affect the improvement of knowledge skills of participants. That means, age is impacting on the remembering skills of farmers.

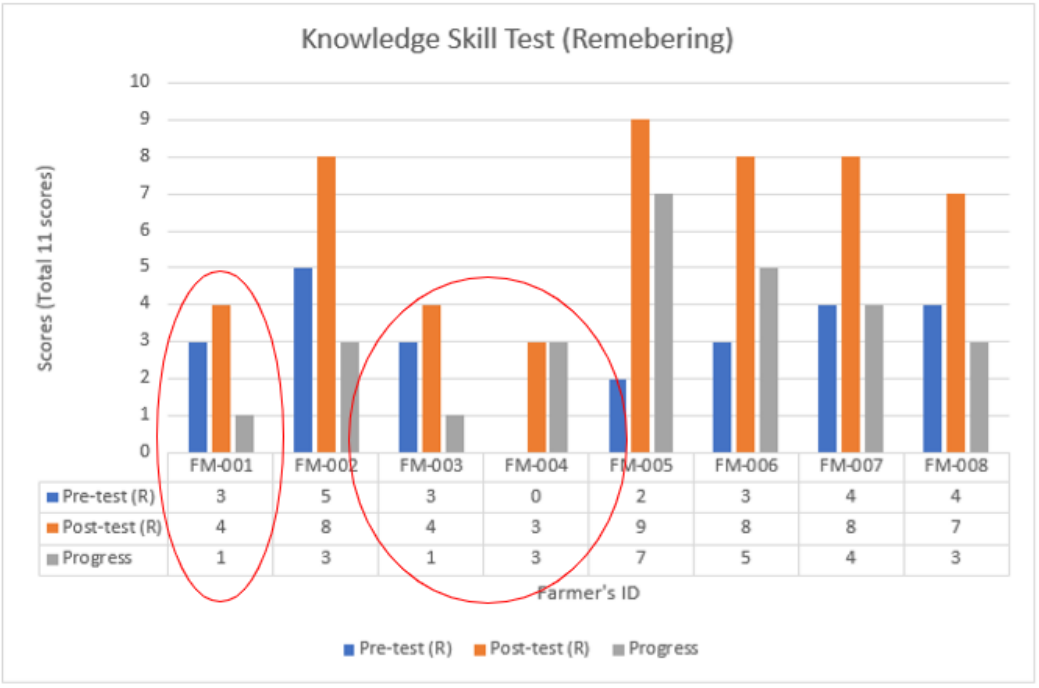



**Figure 9**: Difference progress level of participants: Remembering

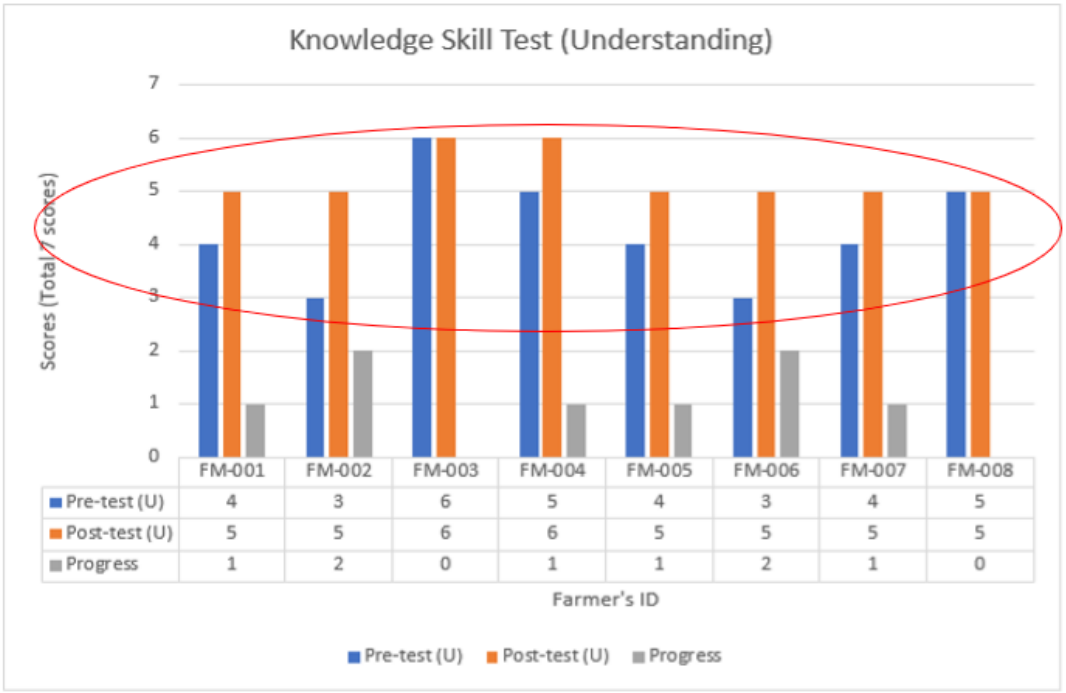



**Figure 10**: Difference progress level of participants: Understanding

### *4.2.3. Farmer's Performance*

Figure 11 to Figure 16 shows the comparison results of farmers' performance before and after participating in our training course. The blue colour is the result of the farmer's performance before attending our training course, and the tan colour is the result of the farmer's performance after attending our training course. The orange colour is the result of the farmer's performance after attending our training course. Based on the results, most

participants can improve their performance skills in terms of sensor installation, data reading, irrigation control, and data interpretation.

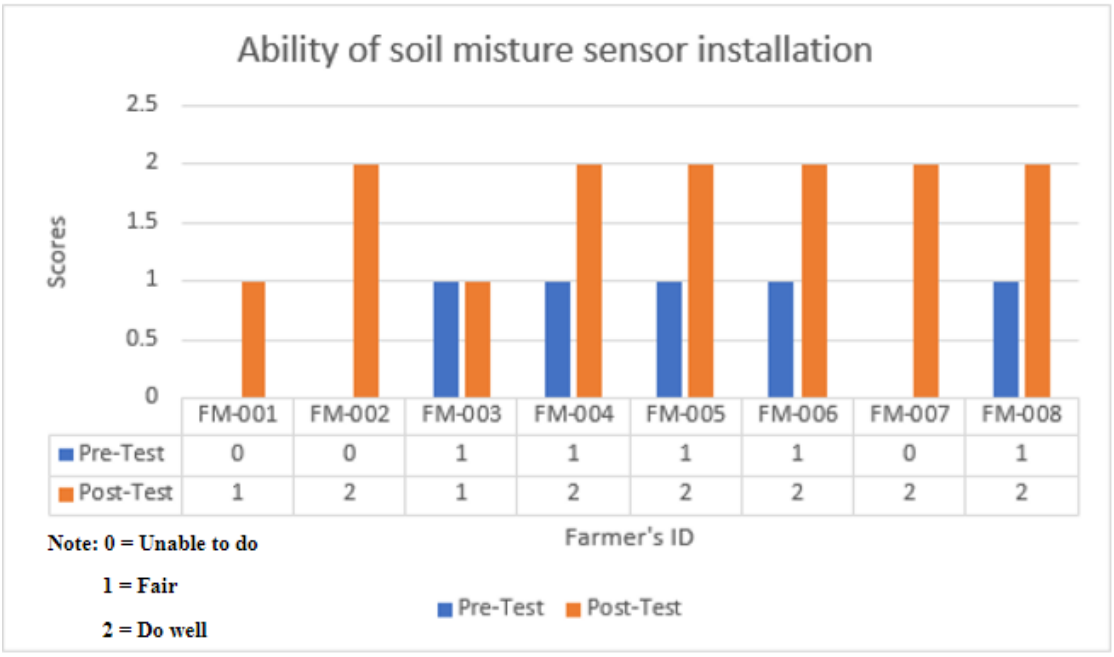



**Figure 11**: Results of farmer's performance in soil moisture sensor installation

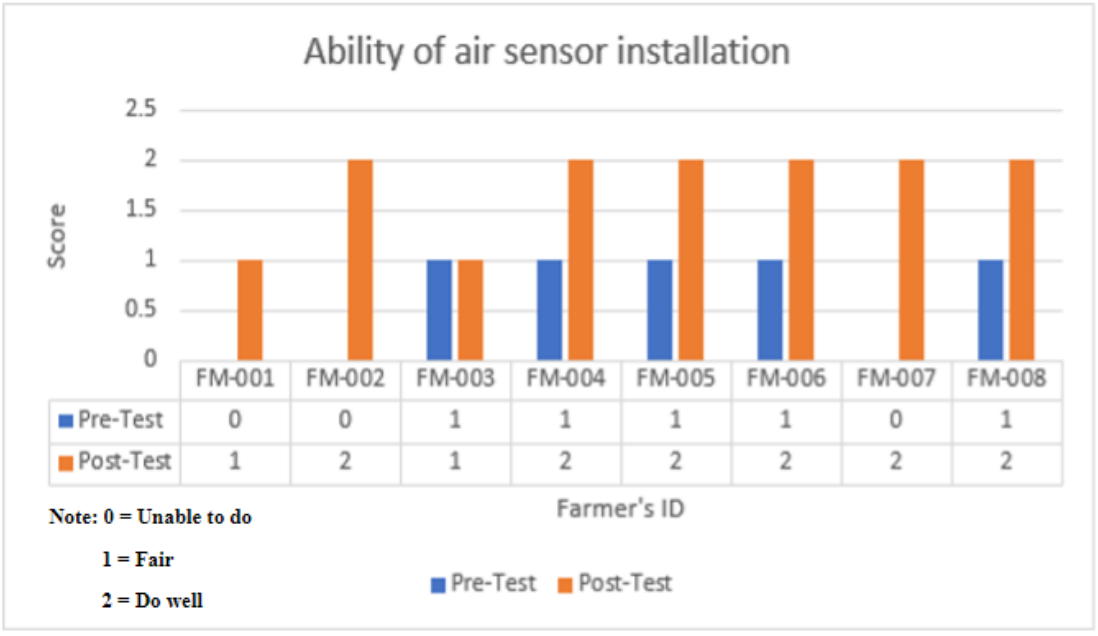



**Figure 12**: Results of farmer's performance in air sensor installation

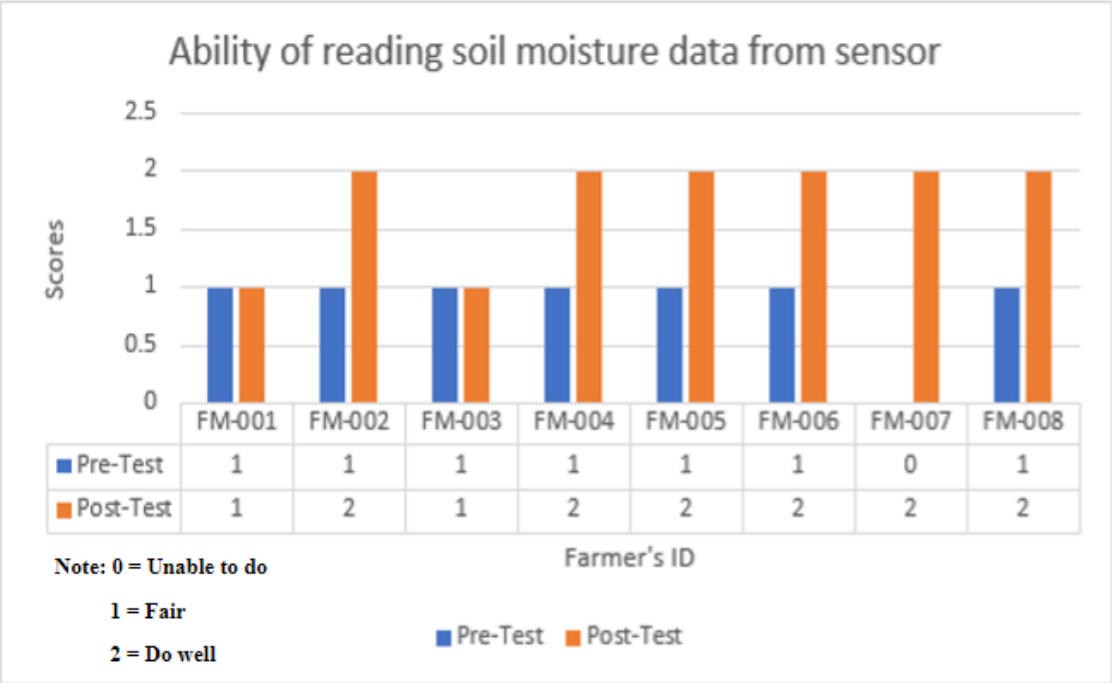



**Figure 13**: Results of farmer's performance in soil moisture data reading

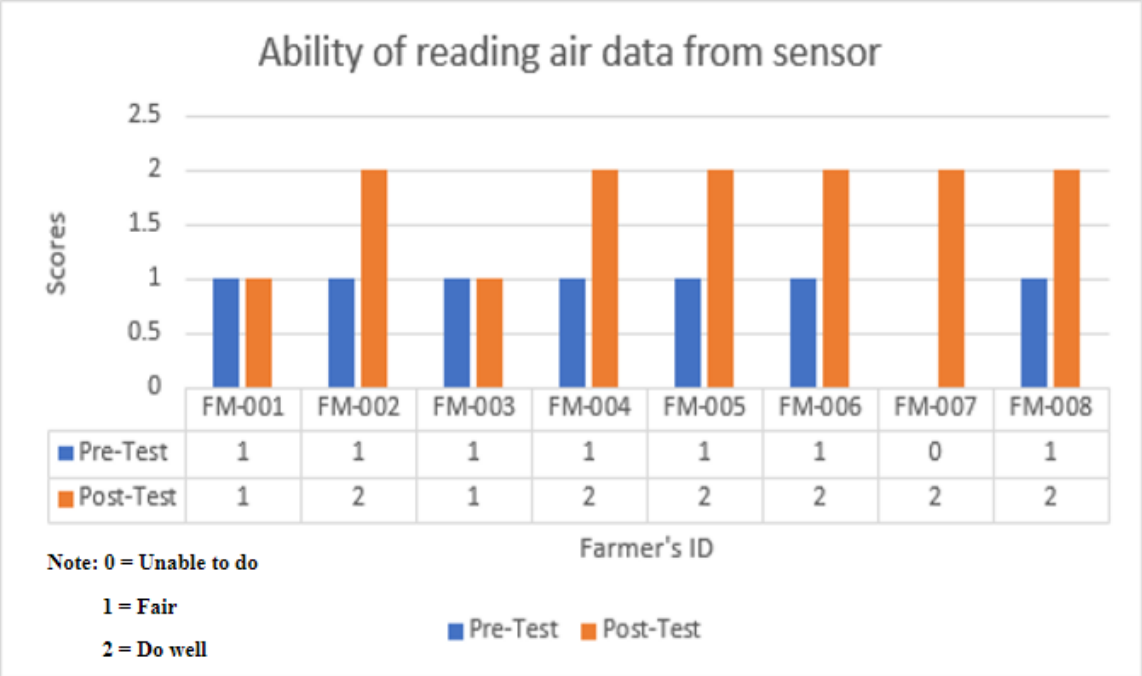



**Figure 14**: Results of farmer's performance in air data reading

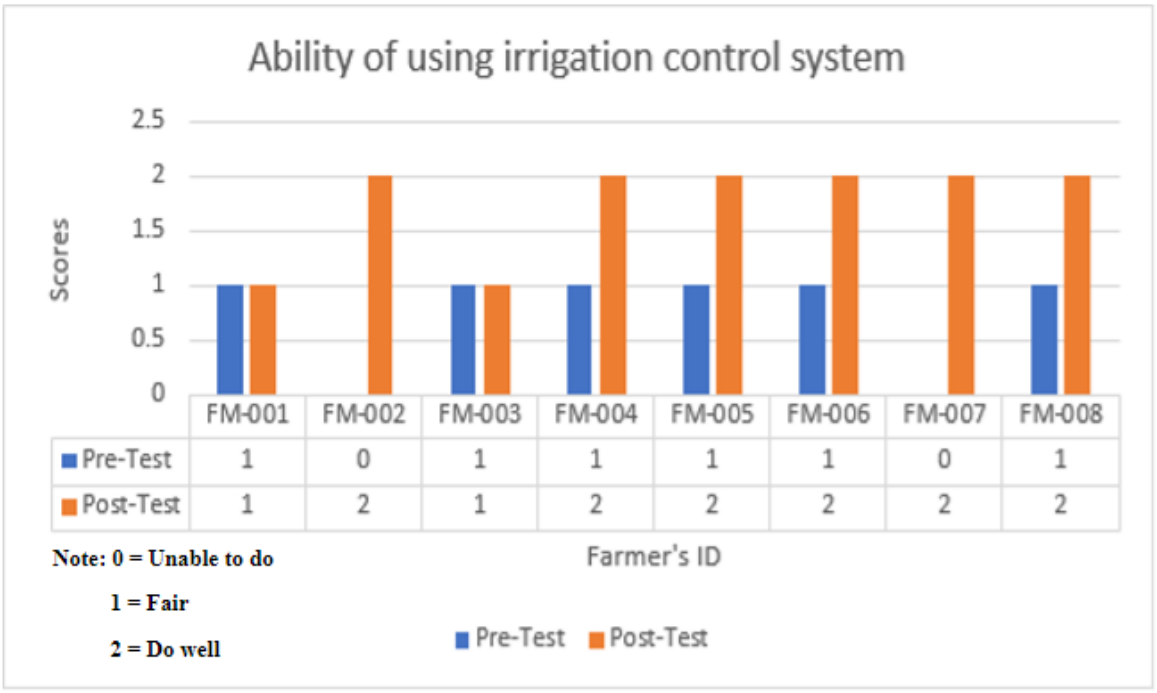



**Figure 15**: Results of farmer's performance in irrigation control system usage

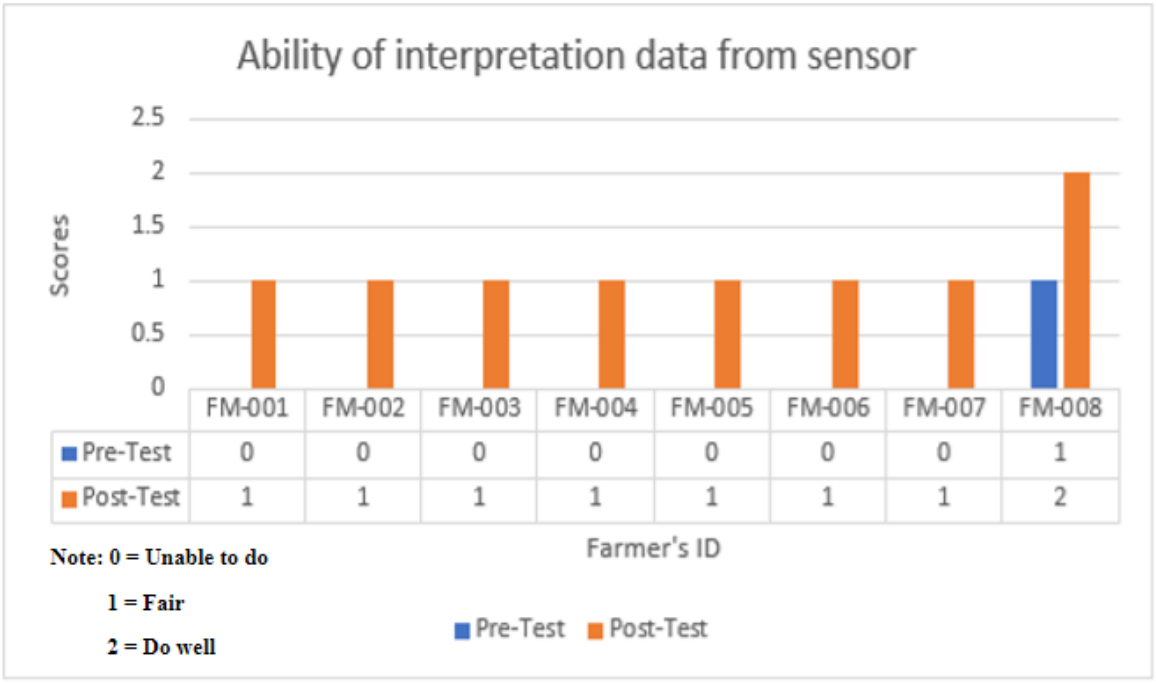



**Figure 16**: Results of farmer's performance in data interpretation

### 4.2.4. Mobile Learning Platform Satisfaction

**Table 5**: Results of mobile learning satisfaction

| | Farmer's ID | | | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | FM-001 | FM-002 | FM-003 | FM-004 | FM-005 | FM-006 | FM-007 | FM-008 | Score | % |
| Response of mobile learning platform with users | 5 | 3 | 5 | 5 | 5 | 5 | 5 | 3 | 36 | 90.00 |
| Easy to use | 5 | 3 | 5 | 5 | 5 | 5 | 4 | 5 | 37 | 92.50 |
| No problems of using platform by users | 5 | 2 | 4 | 5 | 4 | 5 | 4 | 4 | 33 | 82.50 |
| Accessibility anytime and anywhere | 5 | 5 | 5 | 5 | 4 | 5 | 5 | 5 | 39 | 97.50 |
| Smoothly interaction with the platform | 5 | 3 | 5 | 5 | 4 | 5 | 4 | 5 | 36 | 90.00 |
| No internet connection issues during the use of the application | 5 | 3 | 5 | 5 | 5 | 5 | 5 | 5 | 38 | 95.00 |
| Clear and visible of Images, texts and sounds in platform | 5 | 2 | 5 | 5 | 5 | 5 | 5 | 5 | 37 | 92.50 |
| Interesting contents | 5 | 3 | 5 | 5 | 5 | 5 | 5 | 5 | 38 | 95.00 |
| The appropriate of contents | 5 | 4 | 5 | 5 | 5 | 5 | 4 | 5 | 38 | 95.00 |
| Flexibility of learning via mobile learning platform | 5 | 3 | 5 | 5 | 5 | 5 | 5 | 5 | 38 | 95.00 |
| User's time saving by learning via mobile learning platform | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 40 | 100.00 |
| Learning via mobile learning platform offers the opportunity to users getting information faster than from classroom learning. | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 40 | 100.00 |
| | 60 | 41 | 59 | 60 | 57 | 60 | 56 | 57 | Grand total Score | |
| Total % | 100.00 | 68.33 | 98.33 | 100.00 | 95.00 | 100.00 | 93.33 | 95.00 | 450 | 93.75 |

Table 3 shows the results of participants' satisfaction with mobile learning usage. Based on the results, our mobile-learning was able to improve the knowledge of farmers at both remembering and understanding levels. The knowledge progress of participants is a difference. Three participants had low progress in remembering questions, which related to the age factor (average is 55 years old). Mobile learning might not be suitable for people older than 50. Almost every participant has similar scores on understanding the questions from pre and post-test. try to improve workshop design that increases understanding level.

### 4.2.5. Workshop/Training Satisfaction

**Table 6**: Results of training satisfaction

| | Farmer's ID | | | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | FM-001 | FM-002 | FM-003 | FM-004 | FM-005 | FM-006 | FM-007 | FM-008 | Score | % |
| Training quality | 5 | 3 | 5 | 5 | 5 | 5 | 4 | 5 | 37 | 92.5 |
| The suitability of training arrangements | 5 | 4 | 5 | 5 | 4 | 5 | 4 | 5 | 37 | 92.5 |
| The appropriate and the applicable of online teaching and learning content | 5 | 4 | 5 | 5 | 5 | 5 | 4 | 5 | 38 | 95 |
| Meet the needs of the learners | 5 | 4 | 5 | 5 | 4 | 5 | 4 | 5 | 37 | 92.5 |
| The appropriate of training time | 5 | 3 | 5 | 5 | 4 | 5 | 4 | 5 | 36 | 90 |
| Overview of the satisfaction of this training | 5 | 3 | 5 | 5 | 5 | 5 | 4 | 5 | 37 | 92.5 |
| Total score | 30 | 21 | 30 | 30 | 27 | 30 | 24 | 30 | Grand total Score | |
| Total % | 100 | 70 | 100 | 100 | 90 | 100 | 80 | 100 | 222 | 92.5 |

Table 4 shows the results of participants' satisfaction with our training course. Based on the results, participants were satisfied with our training course because they could improve their skills both knowledge and performance skills. We got high scores on all topics from most of the participants. There are two topics that we need to improve in our training course: training time and workshop practice. Due to the limitation of time during the training organized in Chiang Mai, Thailand, we organized only one day so that participants would require more time for learning, demonstration, and practicing.

# Annex

## 1. Pilot Outcome: Result measurement

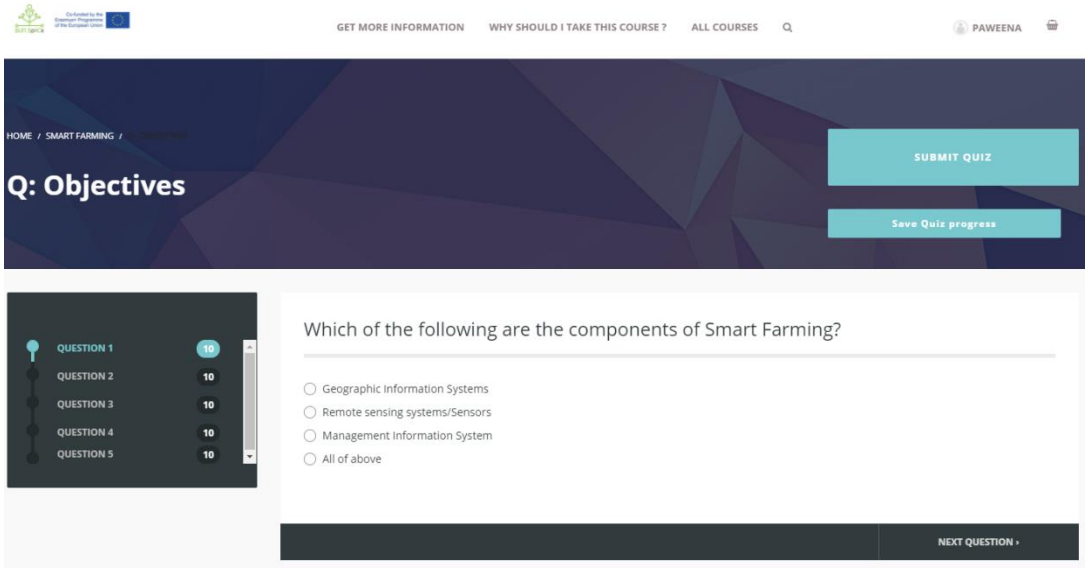
TQA-RS1.CMU1

**Result Measurement Template**

**Pilot name:** **Organic Farming**
**Partner name:** **CMU**

| Result code | Result | Description | Result Measurement | Scoring Criteria |
|---|---|---|---|---|
| [RS-PLQ2] | 1. Increase the size of products | The size of farming products reached the market standard (10 cm.) | Product Weight | Increase = 1<br>No increase = 0 |
| [RS-PLQ3] | 2. No dark spot of products | The color of leaves does not have any dark spots, the leaves are all green. | Product color | No dark spot = 1<br>Have dark spot = 0 |
| [RS-MIP1] | 3. Reduce the use of water for irrigation | The amount of water used for irrigation is reduced (50%) | Water management (time/amount of water used for irrigation) | Reduce = 1<br>No reduce = 0 |
| [RS-MIP2] | 4. Reduce the use of chemical substances | Do not use chemical substances (100%) | Chemical management (amount of chemical used for production) | No use = 1<br>Still use = 0 |
| [RS-MIP3] | 5. Reduce the use of fertilizer | The amount of fertilizer used is reduced (50%) | fertilizer management (time/amount of fertilizer) | Reduce = 1<br>No reduce = 0 |
| [RS-ECM1] | 6. Chemical contamination in soil | No chemical contamination in soil | Soil management (measure level of chemical contamination in soil using tool kit) | Don't have = 1<br>Still have = 0 |
| [RS-ECM2] | 7. Chemical contamination in water | No chemical contamination in water | Watermanagement (measure level of chemical contamination in water using tool kit) | Don't have = 1<br>Still have = 0 |

## 2. Pre-test: TQA-PT1 (Farmer's Knowledge Assessment Form)



## Performance Assessment sheet

Workshop name: _____

Date: _____

Name of participant: _____ Learner ID: _____

Pilot Name: _____ Country: _____

Please use the following criterias to performance assessment.

| Result code | Result | Workshop activities | Score | |
|---|---|---|---|---|
| | | | Y | N |
| [PT2-POT1] | | | | |
| [PT2-POT2] | | | | |
| [PT2-POT3] | | | | |
| | | | | |
| | | | | |

Y = able to perform (1 Points)
N = unable to perform (0 Points)

## *4. Pre-test: TQA-PT3.X (Farm Audit Assessment Form)*

TQA-PT3.CX

**Pilot Project Outcome Worksheet**
Name of participant: _____**Self Audit**_____

Name of participant: _____ Learner ID: _____
Pilot Name: _____ Country: _____

| Result code | Result | Score | |
|---|---|---|---|
| | | Yes | No |
| [RS-PLQ2] | The size of farming products reached the market standard (10 cm.) | | |
| [RS-PLQ3] | The color of leaves does not have any dark spots, the leaves are all green. | | |
| [RS-MIP1] | The amount of water used for irrigation is reduced (50%) | | |
| [RS-MIP2] | Do not use chemical substances (100%) | | |
| [RS-MIP3] | The amount of fertilizer used is reduced (50%) | | |
| [RS-ECM1] | No chemical contamination in soil | | |
| [RS-ECM2] | No chemical contamination in water | | |

## *5. TQA-RA1: Mobile Learning Satisfaction Form*

Assessment Code TQA-RA1

Tester Code .....

**Mobile Learning Platform Satisfaction Survey**

**Level of satisfaction**
5 = Excellent 4 = Good 3 = Average 2 = Poor 1 = Very poor

**Please check the cross mark on each object in the level value box.**

| Items | Satisfaction Level | | | | |
|---|---|---|---|---|---|
| | 5 | 4 | 3 | 2 | 1 |
| 1. Through the application, users can easily respond to questions. | | | | | |
| 2. The application can be used easily and uncomplicated. | | | | | |
| 3. Users do not have any problems while using the application | | | | | |
| 4. Users can access the application anytime | | | | | |
| 5. Users can communicate smoothly with the app. | | | | | |
| 6. When using the program, users have no internet problems | | | | | |
| 7. Pictures, texts, and sounds are clear and visible in the mobile application. | | | | | |
| 8. The information is interesting and can be repeatedly learned. | | | | | |
| 9. The information is appropriate for teaching and learning. | | | | | |
| 10. Mobile learning gives users the flexibility to use it at all times. | | | | | |
| 11. Online learning saves users time via a mobile phone. | | | | | |
| 12. Online learning via mobile phone gives users the opportunity to get information faster from the classroom. | | | | | |

**Suggestion**

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## 6. TQA-RA2: Smart Farm Lab Training Satisfaction Form

Assessment Code TQA-RA2

Tester Code .....

### The Smart Farm Laboratory Training Activity Satisfaction Assessment Form

**Level of Satisfaction**

5 = Excellent 4 = Good 3 = Average 2 = Poor 1 = Very Poor

**Please place a check mark to determine your level of competence in managing water usage in agricultural parcels**

| Items | Satisfaction Level | | | | |
|---|---|---|---|---|---|
| | 5 | 4 | 3 | 2 | 1 |
| 1. Quality of training | | | | | |
| 2. The appropriateness of training arrangements | | | | | |
| 3. Online teaching and learning material is suitable and applicable | | | | | |
| 4. Training can completely fulfill the knowledge learners' needs. | | | | | |
| 5. Training period is appropriate | | | | | |
| 6. Overall satisfaction to the training | | | | | |

**Suggestion**

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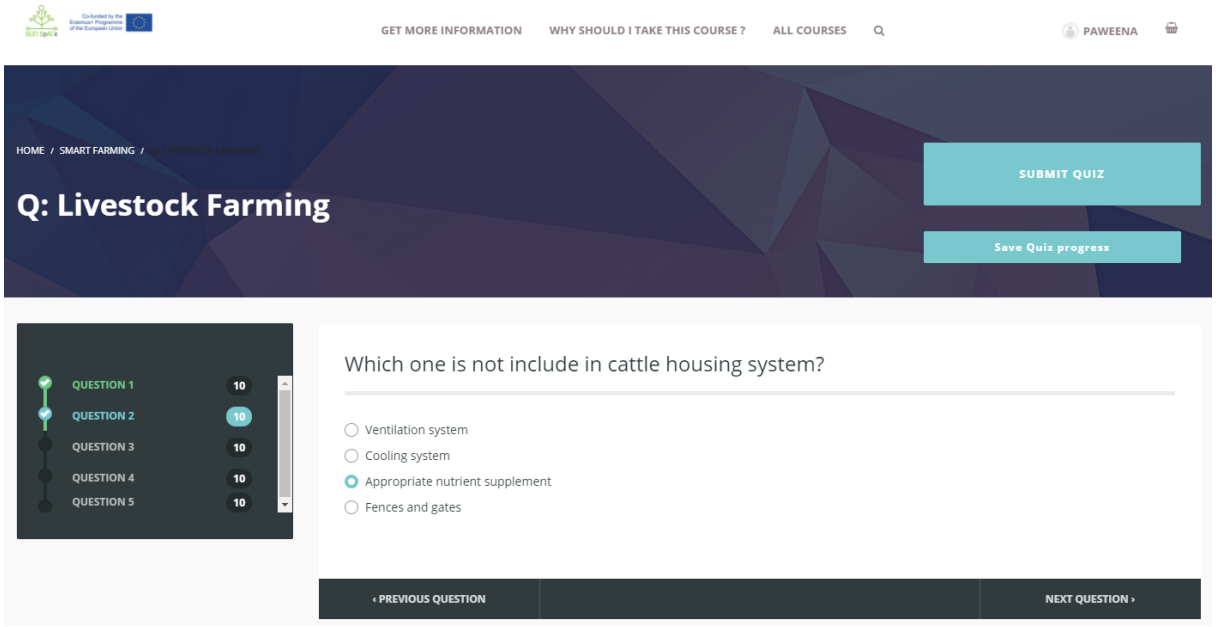
## 7. Post-test: TQA-LE1 (Farmer's Knowledge Assessment Form)



## Farmer's Performance Assessment sheet

Workshop name: _____

Date: _____

Name of participant: _____ Learner ID: _____

Pilot Name: _____ Country: _____

Please use the following criterias to performance assessment.

| Result code | Result | Workshop activities | Score | |
|---|---|---|---|---|
| | | | Y | N |
| [PT2-POT1] | | | | |
| [PT2-POT2] | | | | |
| [PT2-POT3] | | | | |
| | | | | |
| | | | | |

Y = able to perform (1 Points)
N = unable to perform (0 Points)

## 9. Post-test: TQA-RS1.X (Farm Audit Assessment Form)

TQA-RS1.X

**Pilot Project Outcome Worksheet**

| Project Outcome | Criteria | Description | Result |
|---|---|---|---|
| Productivity | Quantity | The smart farming system/technology helps farmers to increase the quantity of yields. | □ Increase the quantity of yields [RS-PQT1]<br>□ Reduce the loss of yields [RS-PQT2]<br>□ Increase average daily gain [RS-PQT3]<br>□ Other ..... |
| | Quality | The smart farming system/technology helps farmers for enhancement of the quality of yield, to get better quality of yields. | □ Increase the sweetness [RS-PQL1]<br>□ Increase the size of products[RS-PQL2]<br>□ No dark spot of products [RS-PQL3]<br>□ Other..... |
| Management | Cost | The smart farming system/technology helps farmers to less spend money for agricultural production. | □ Reduce labour cost [RS-MCS1]<br>□ Reduce infrastructure cost [RS-MCS2]<br>□ Reduce fixed cost [RS-MCS3]<br>□ Other ..... |
| | Input | The smart farming system/technology helps farmers to use less amount of input for caring agricultural products that will help to reduce the contamination of chemicals in agricultural products. | □ Reduce the use of water for irrigation [RS-MIP1]<br>□ Reduce the use of chemical substances [RS-MIP2]<br>□ Reduce the use of chemical fertilizer [RS-MIP3]<br>□ Other ..... |
| | Processes | The smart farming system/technology helps farmers to improve their farm management processes during agricultural production. | □ Improving farm production processes[RS-MPC1]<br>□ Adoption of smart technology for precision farming [RS-MPC2]<br>□ Adoption of machines for farming instead of human labour [RS-MPC3]<br>□ Other ..... |
| Environmental Impacts | CO2 | The smart farming system/technology helps farmers to reduce the CO2 contamination in the air that might impact the environment and the growth of agricultural products. | □ Reduction in CO2 emissions[RS-ECO1]<br>□ Other..... |
| | Chemical | The smart farming system/technology helps farmers to manage the chemical in the environment. | □ Chemical contamination in soil [RS-ECM1]<br>□ Chemical contamination in water [RS-ECM2]<br>□ Other..... |

# Bibliography

**Adams, N. E.** (2015), "Bloom's Taxonomy of Cognitive Learning Objectives", J. Med. Lib. Assoc.103 (3): pp. 152-153. https://doi.org/10.3163/1536-5050.103.3.010

**Allen R E** (1990) The concise Oxford dictionary of current English, 8th edn. Oxford: Claredon Press.

**Biggs, J.B.** (1999) Teaching for quality learning at University, Buckingham: Open University Press.

**Biggs, J.B.** and Collis, K.F. (1982) Evaluating the quality of learning: The SOLO taxonomy (Structure of the Observed Learning Outcome), New York: Academic Press.

**Bloom, B.S.,** Engelhart, M.D., Furst, E.J., Hill, W.H. and Krathwohl, D.R. (1956) Taxonomy of educational objectives Handbook 1: cognitive domain, London: Longman Group Ltd.

**Bloom, B.,** Hastings, J. T., & Madaus, G. F. (1971), Handbook on Formative and Summative Evaluation of Student Learning. New York: McGraw-Hill, 923 p.

**Bransford, J.D.,** Brown, A.L. and Cocking, R.R. (2000) How people learn: brain, mind, experience, and school, Expanded Edition edn. Washington: National Academy Press.

**Chen, L.,** & Mohamed, S. (2010). The strategic importance of tacit knowledge management activities in construction. Construction Innovation, 10(2), 138-163.

**Chrissis, M.B.,** Kourad, M. and Shrum, S. (2003) CMMI Guidelines for process integration and product improvement, Boston: Addison-Wesley.

**Costa, A.L.** and Liebmann, R.M. (1996) Envisioning process as content: Toward a renaissance curriculum, Thousand Oaks, CA: Corwin Press Inc.

**Davenport, T.,** & and Klahr, P. (1998). Managing customer support knowledge. California Management Review, 37, 195-208.

**Gold, A. H.,** Malhotra, A., & and Segars, A. H. (2001). Knowledge management: an organizational capabilities perspective. Journal of Management Information Systems, 18(1), 185-214.

**Kalling, T.** (2003). Knowledge management and the occasional links with performance. Journal of Knowledge Management, 7(3), 67-81.

**Kirkpatrick D.L.** (1998) The Four Levels of Evaluation. In: Brown S.M., Seidner C.J. (eds) Evaluating Corporate Training: Models and Issues. Evaluation in Education and Human Services, vol 46. Springer, Dordrecht. https://doi.org/10.1007/978-94-011-4850-4_5

**Krathwohl, D. R.** (2002), "A Revision of Bloom´s Taxonomy: An Overview", Theory into Practice,41(4): pp. 212-218. https://doi.org/10.1207/s15430421tip4104_2

**Hunt, L.M.** (1995) Approaches to learning: The selection and use of learning strategies. Massey University.

**Lierni, P. C.** (2004). A study of relationship between improving the management of project and the use of knowledge management. American University, Faculty of the College of Arts and Sciences. Washington D.C.: American University.

**Poppendieck, M.** (2003) Toward a new definition of maturity [Internet] Available from <http://www.poppendieck.com/maturity.htm> [Accessed 3 March 2021].

**Weigel, F. K.** & Bonica, M. (2014), "An Active Learning Approach to Bloom's Taxonomy: 2Games, 2 Classrooms, 2 Methods", AMEDD Journal, Jan-March: pp. 21-29.