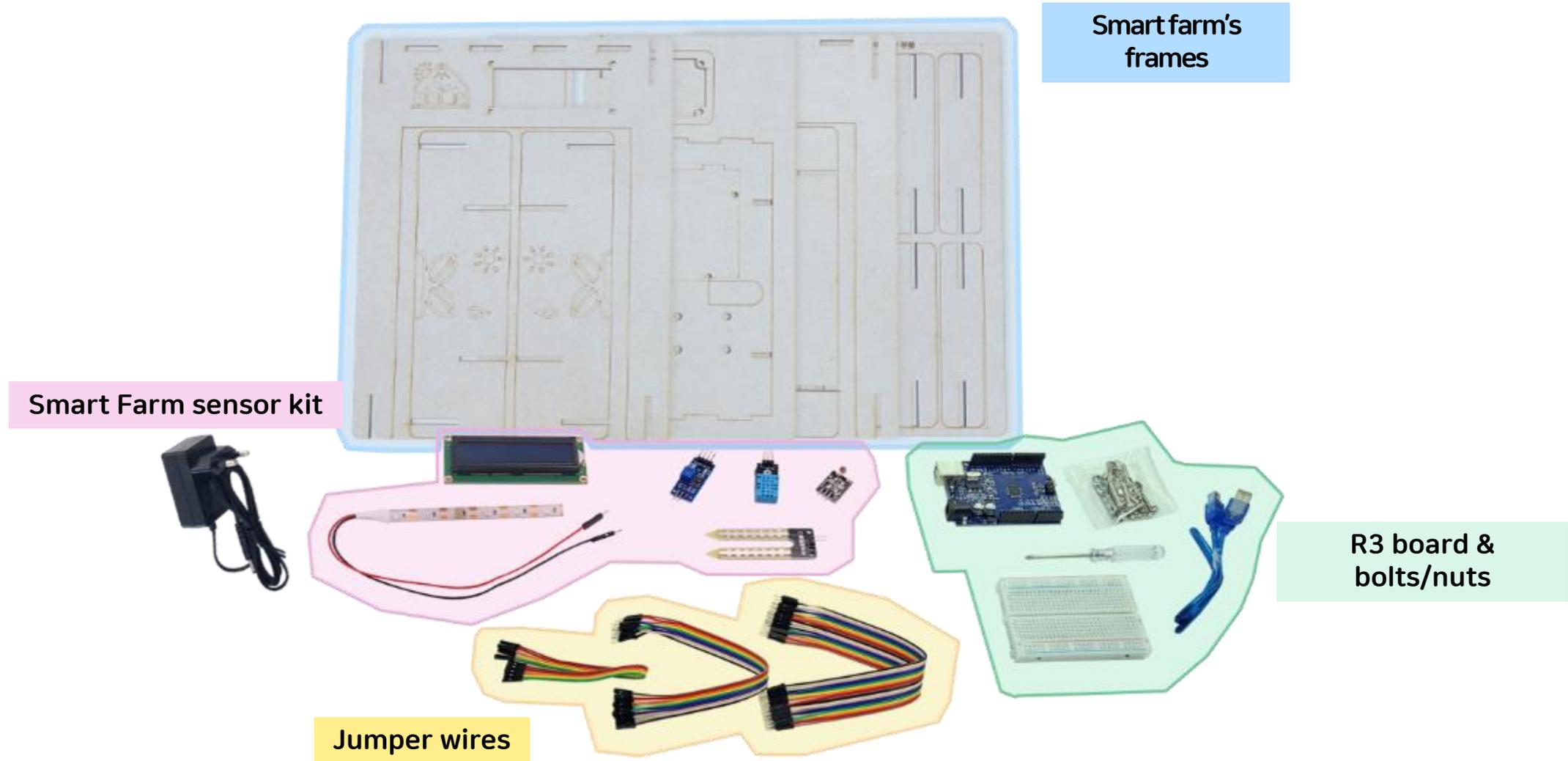


# Assembling Smart Farm



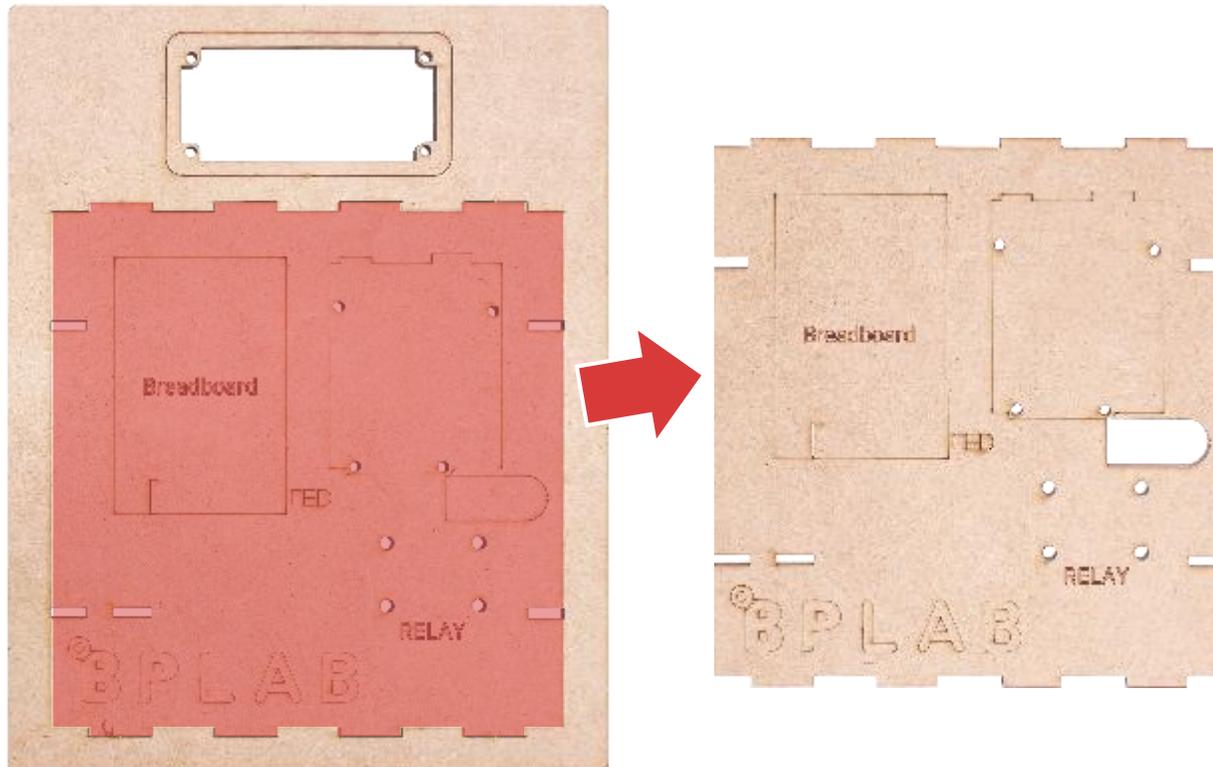
## 2. Assembling Frame

### 2.0. Materials



## 2. Assembling Frame

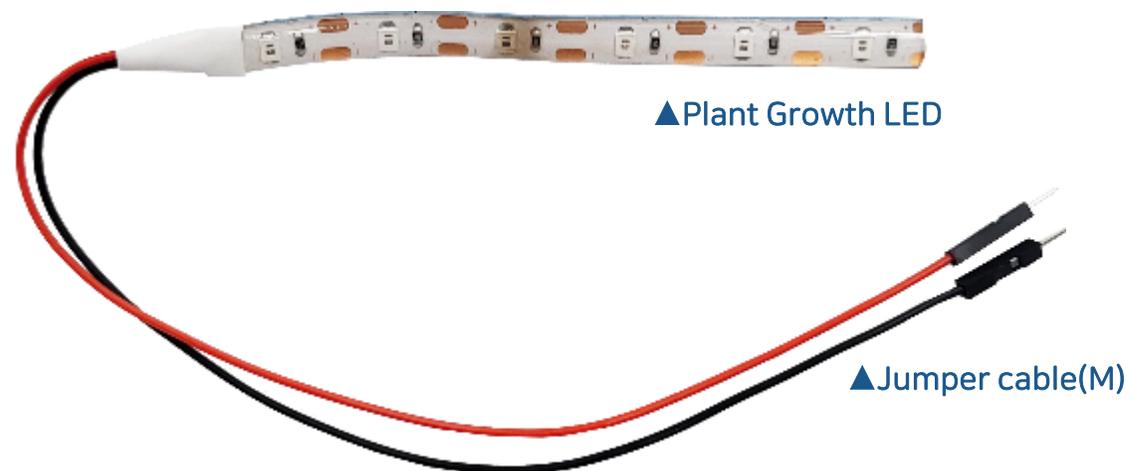
### 2.1. Assembling the sensor in the frame



- ① Remove and prepare **Frame 1** to attach the board and the sensor.

## 2. Assembling Frame

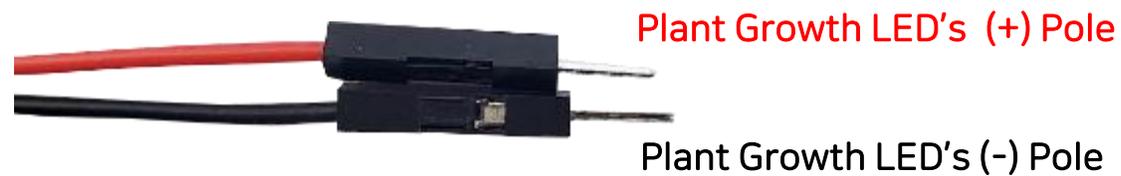
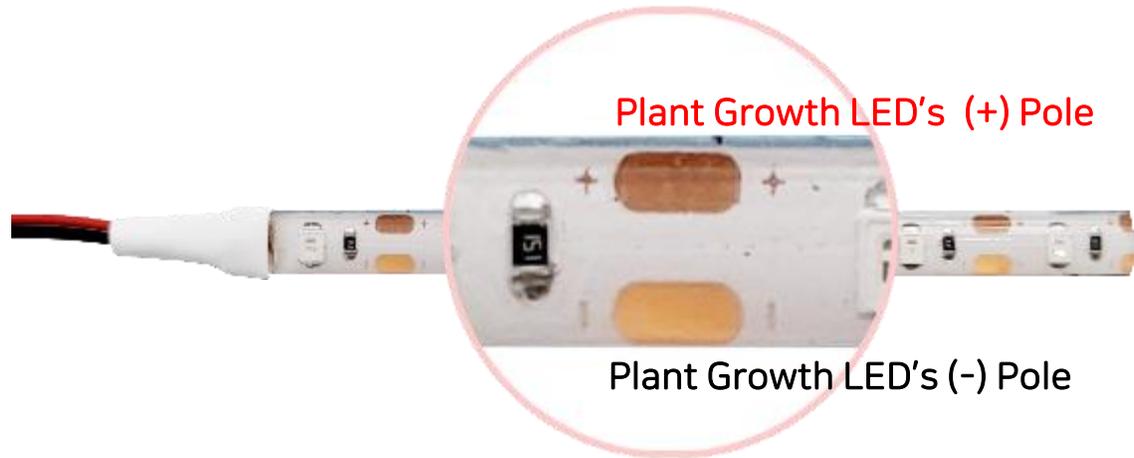
### 2.1. Assembling the sensor in the frame



- ① Take out the Plant Growth LED from the kit

## 2. Assembling Frame

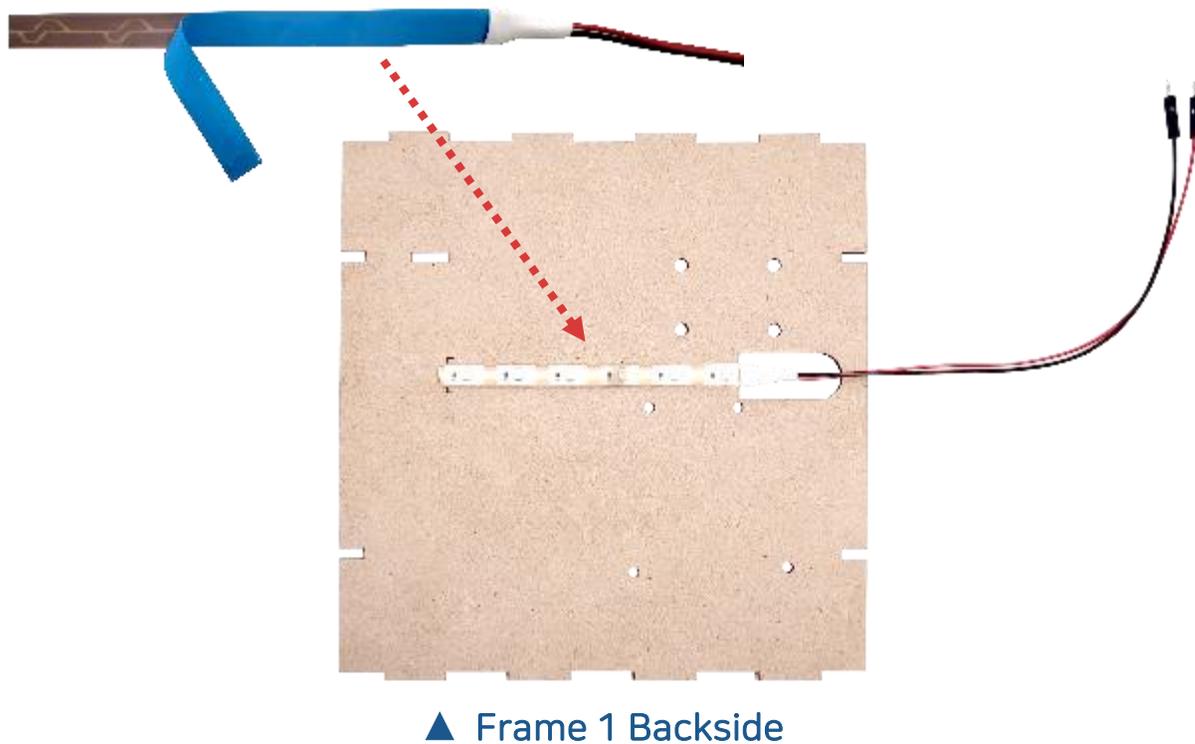
### 2.1. Assembling the sensor in the frame



- ① LED's Red jumper cable is (+) pole
- ② LED's Black jumper cable is (-) pole

## 2. Assembling Frame

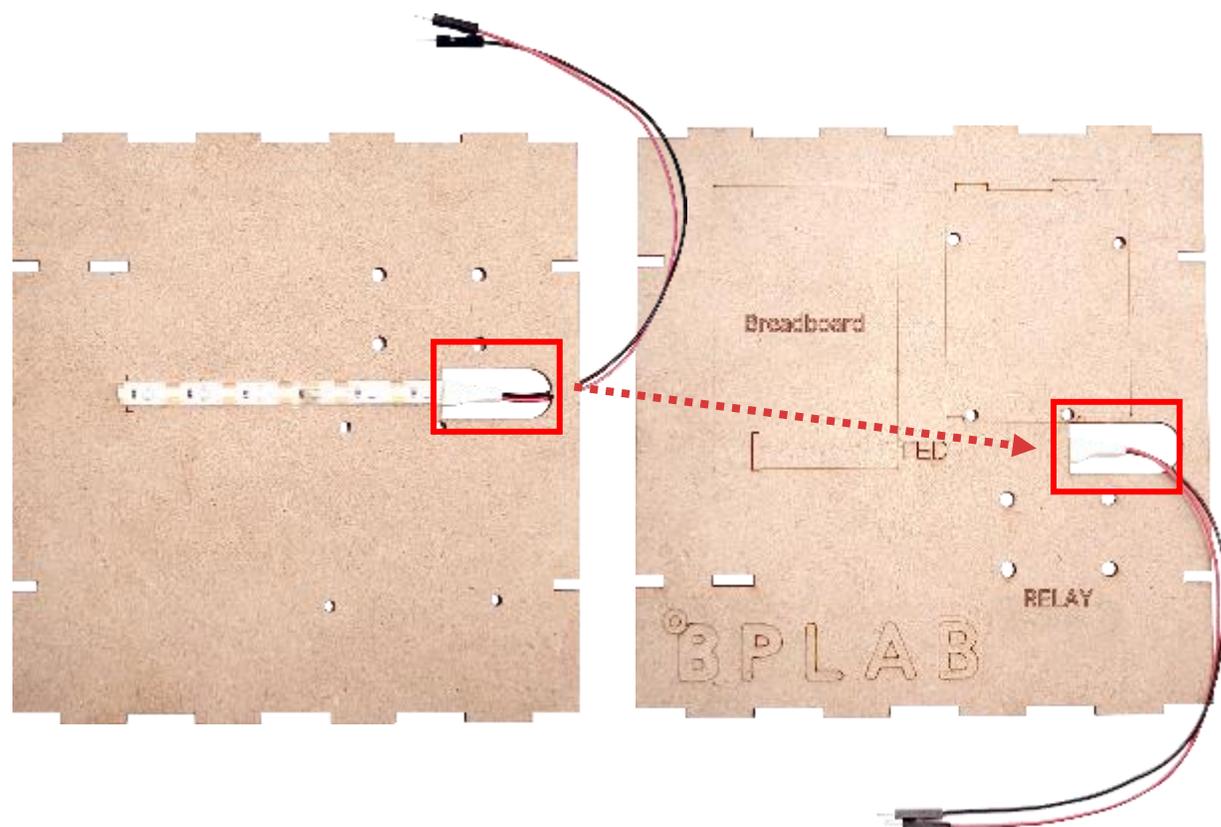
### 2.1. Assembling the sensor in the frame



- ① Remove the sticker from the back of the Plant Growth LED.
- ② Attach the Plant Growth LED to the LED part on the back of Frame 1.

## 2. Assembling Frame

### 2.1. Assembling the sensor in the frame



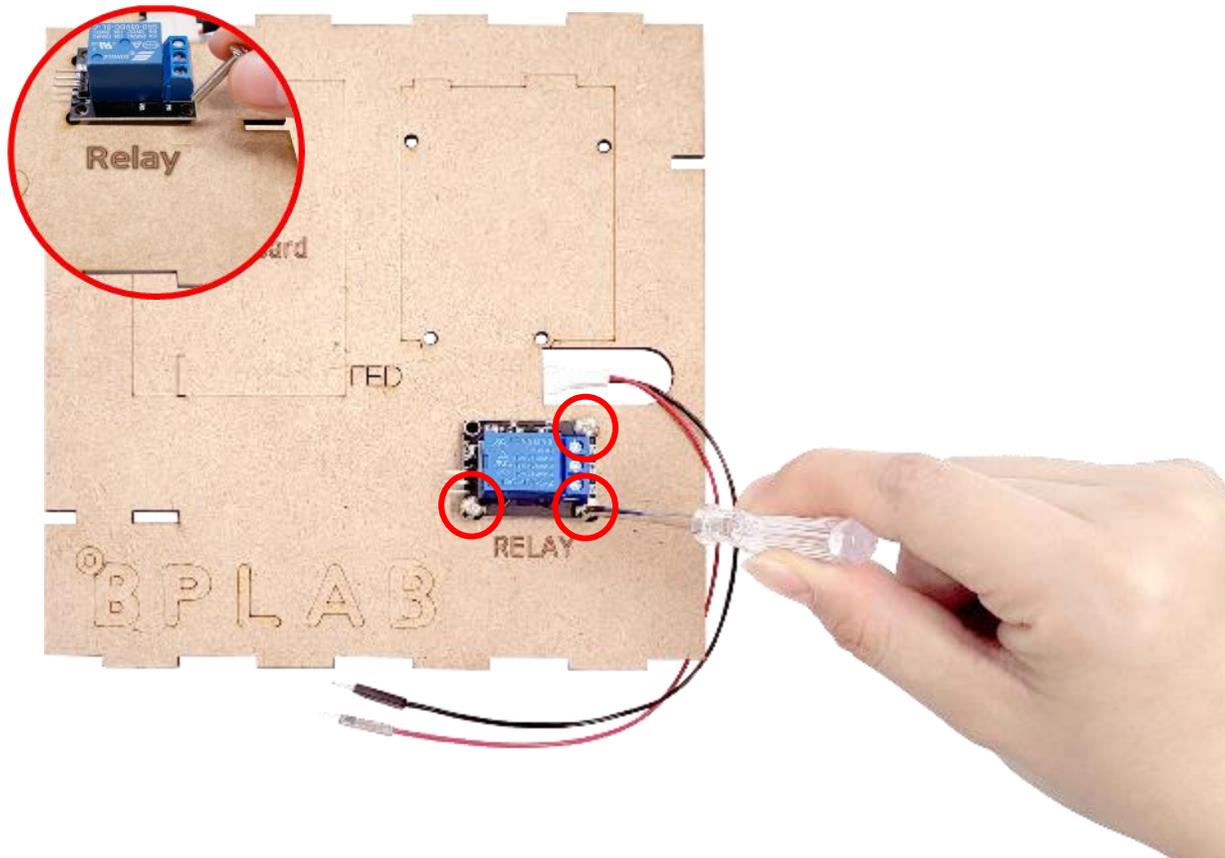
▲ Frame 1 Backside

▲ Frame 1 Frontside

① Place the cable on the frame.

## 2. Assembling Frame

### 2.1. Assembling the sensor in the frame

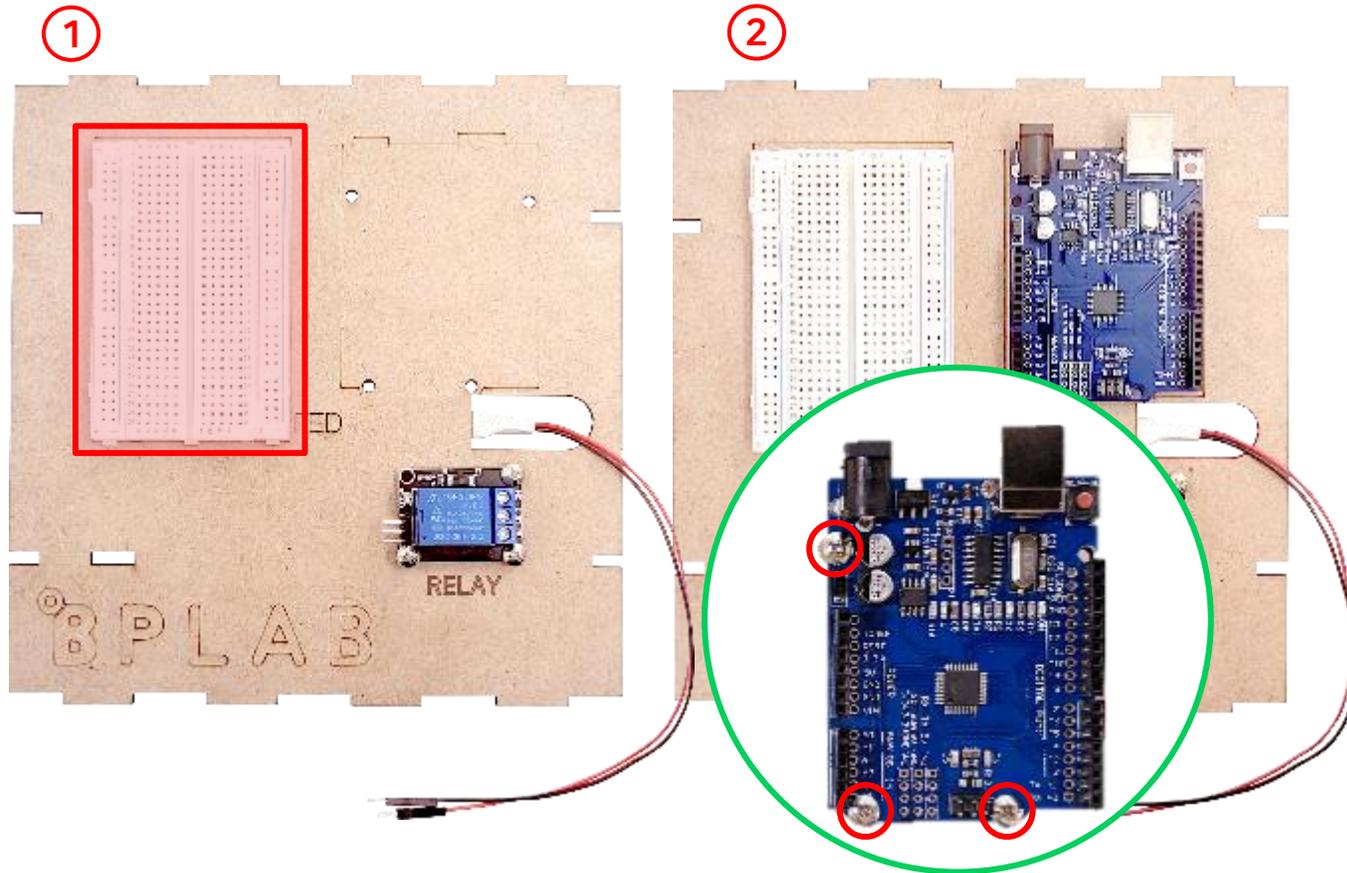


① Fix the relay module to the frame with **M3 bolts/nuts**.

※ Connect the bolts/nuts to the **lower two holes** and the **top right holes** on the relay module.

## 2. Assembling Frame

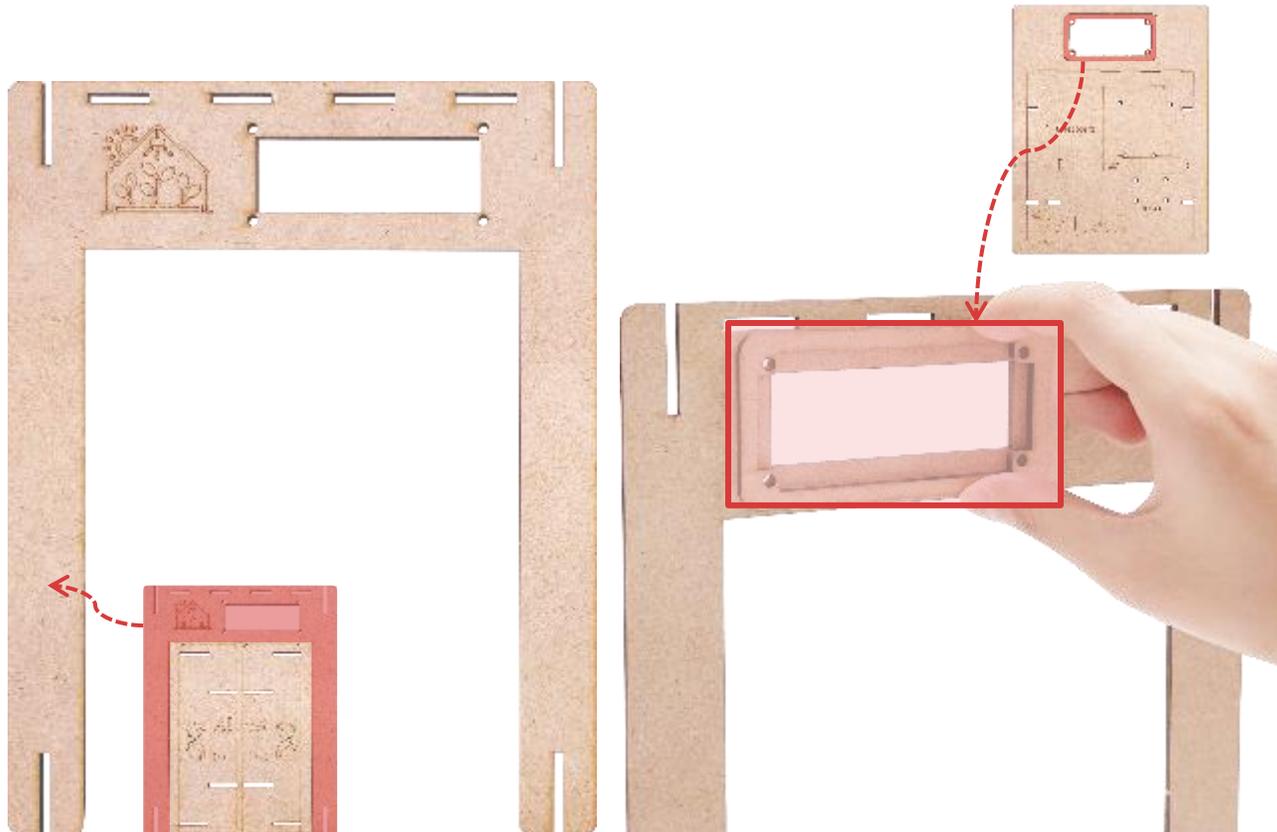
### 2.1. Assembling the sensor in the frame



- ① Remove sticker tape on the breadboard and Attach it to the part that says 'Breadboard' on the frame.
- ② Secure the R3 board with M3 bolts/nuts.  
※ connect the bolts/nuts to the lower two holes and the top right holes on the board.

## 2. Assembling Frame

### 2.2. Assembling the front side of the Smart Farm

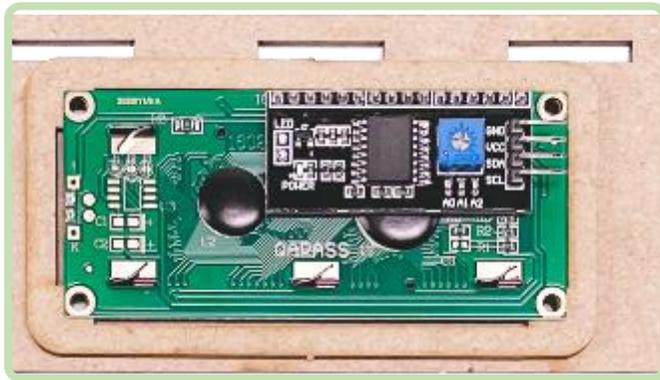


- ① Prepare the Smart Farm's front frame and LCD frame.
- ② Place the frame to fix the LCD on the back of the front frame

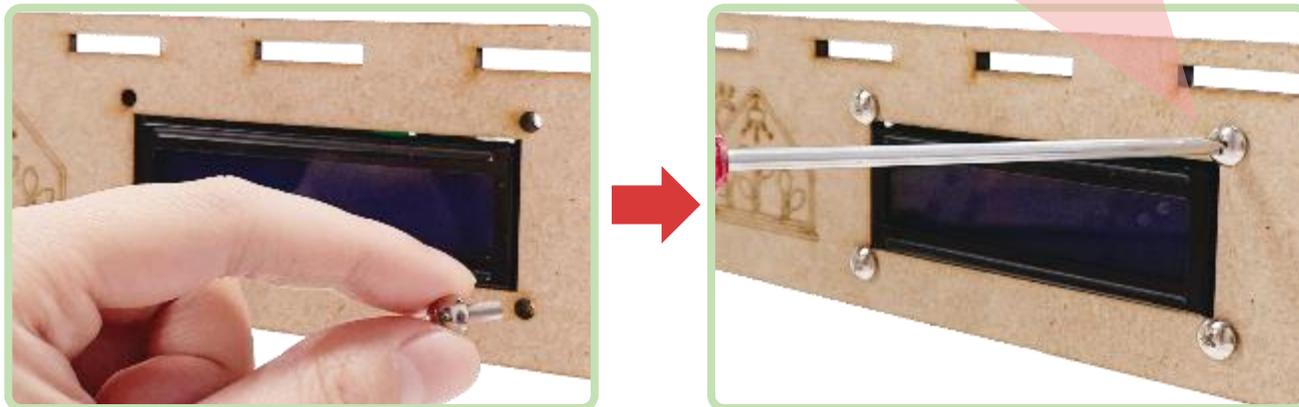
## 2. Assembling Frame

### 2.2. Assembling the front side of the Smart Farm

①



②



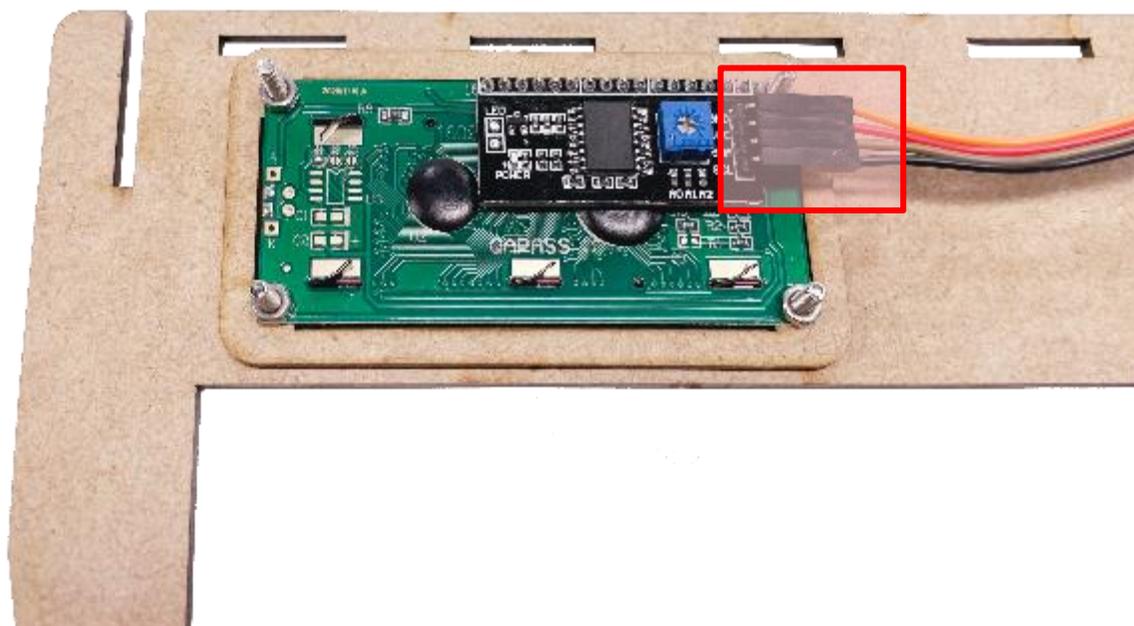
① Insert the LCD module into the LCD fixing frame from behind with the display facing forward.

② Fix using M3 bolts/nuts.

※ If the letters on the back of the LCD module are in the right direction, it is in the correct direction.

## 2. Assembling Frame

### 2.2. Assembling the front side of the Smart Farm

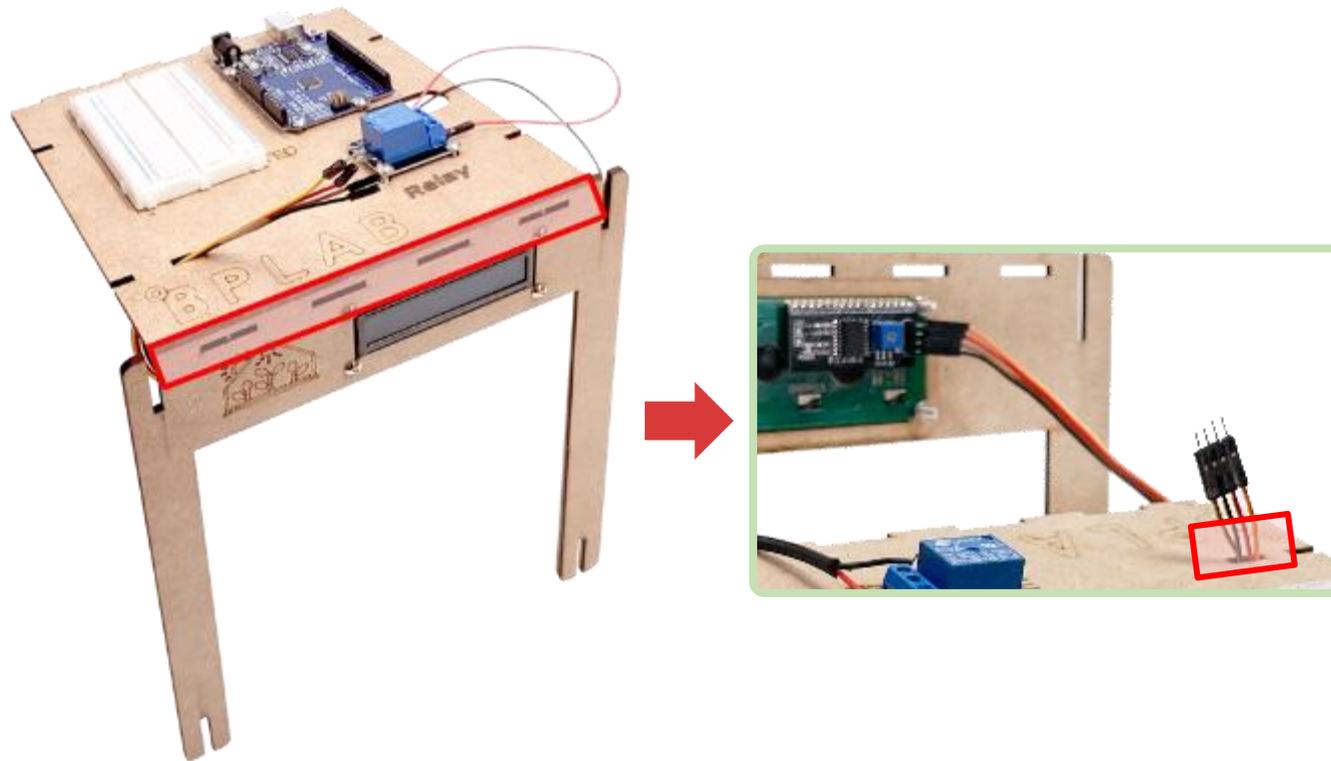


① Connect to the four pins of the LCD module using four female-male jumper wires.

※ No problem even if you use jumper wire of a different color from the picture.

## 2. Assembling Frame

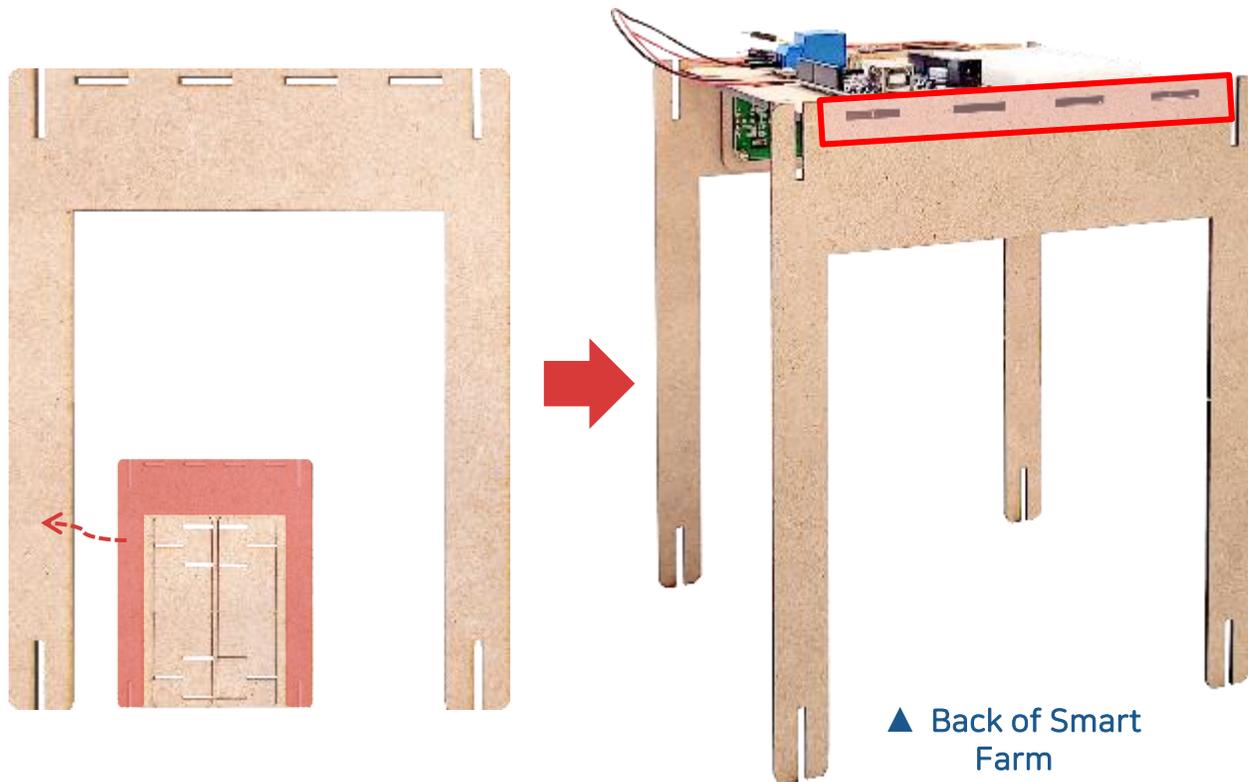
### 2.2. Assembling the front side of the Smart Farm



- ① Connect the sensor frame and the front frame and place the jumper wire connected to the LCD module over the sensor frame.

## 2. Assembling Frame

### 2.3. Assembling the back side of the Smart Farm



- ① Connect the back frame in the same way as the front frame.

## 2. Assembling Frame

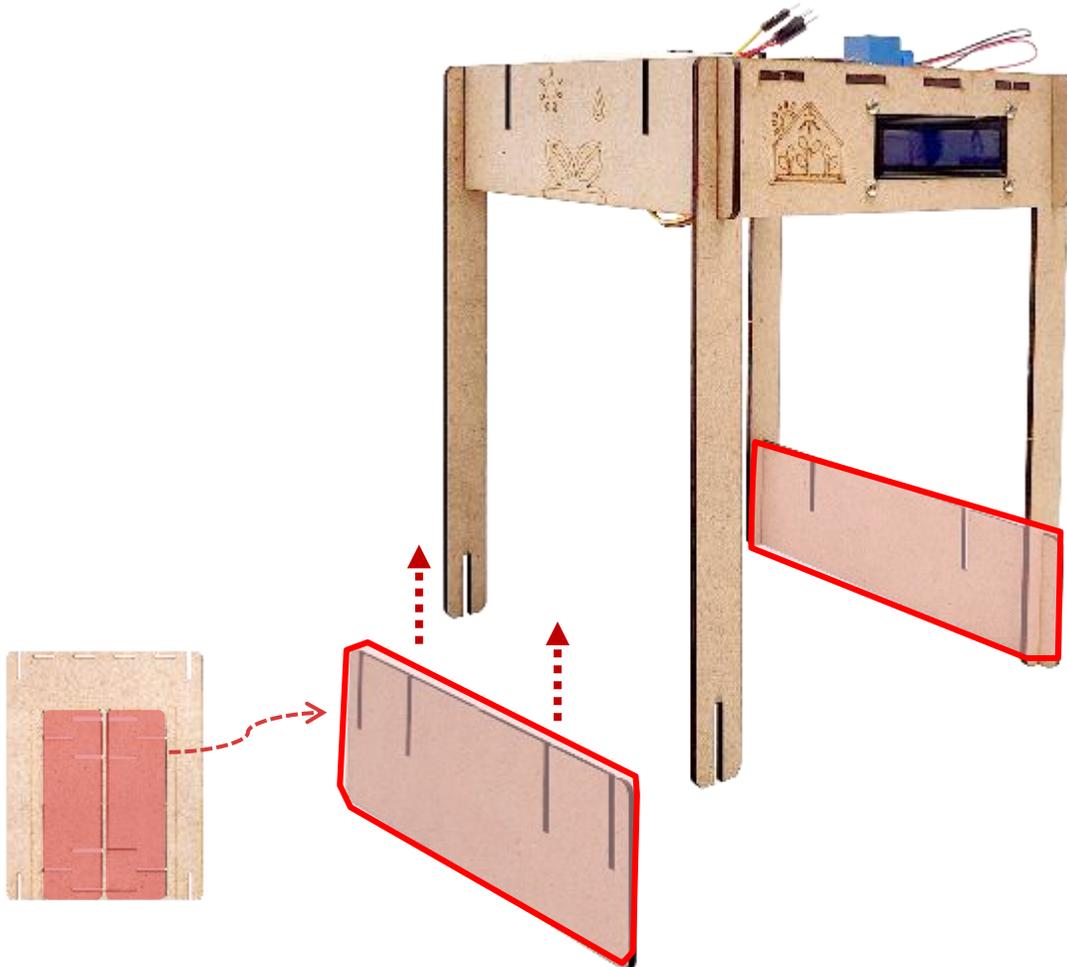
### 2.4. Assembling the left/right side of the Smart Farm



- ① Prepare the support frame as in the picture and connect it to the grooves on the Smart Farm's frame.

## 2. Assembling Frame

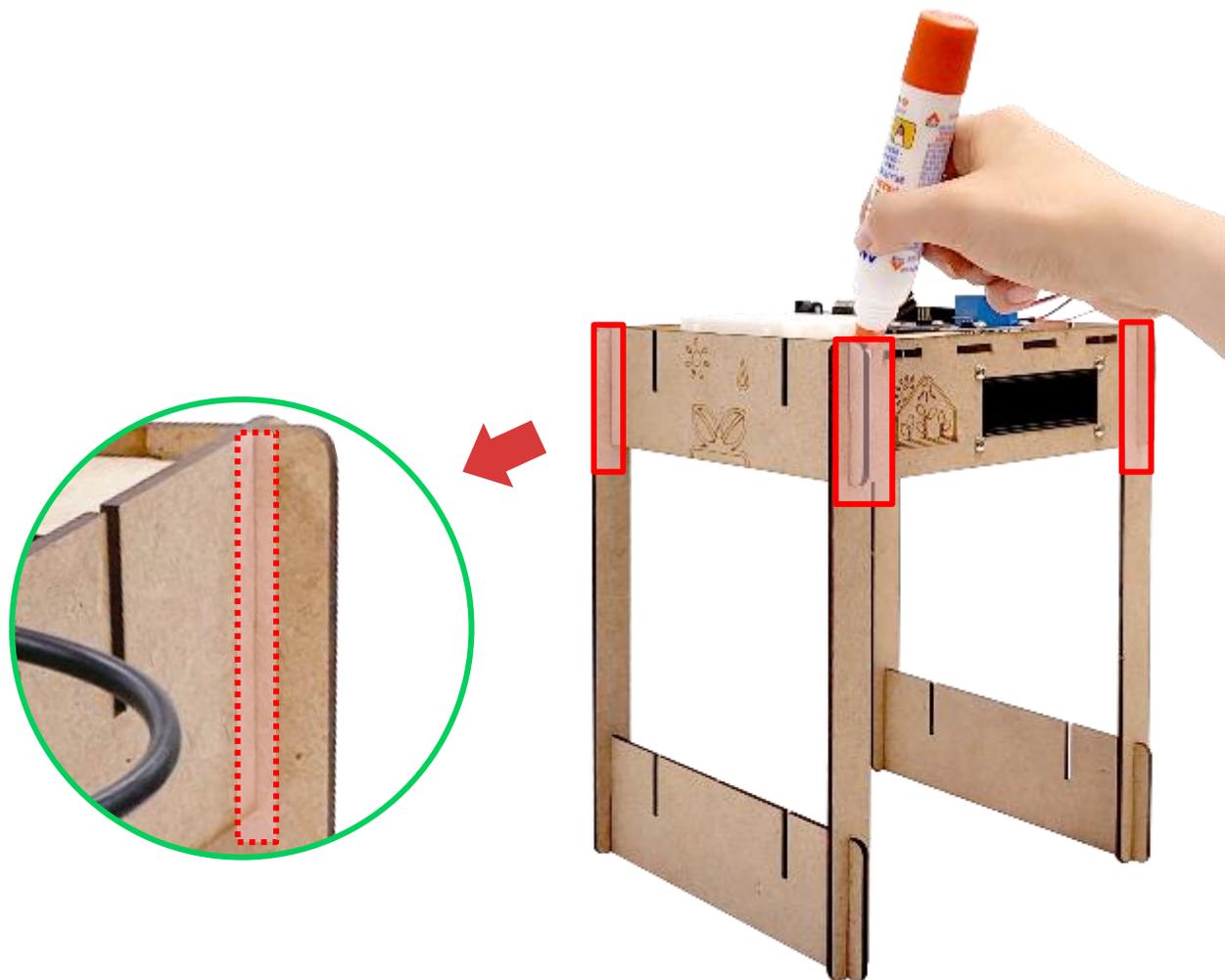
### 2.4. Assembling the left/right side of the Smart Farm



- ① Prepare a support frame without an imprinted picture and connect it to the grooves on the legs.

## 2. Assembling Frame

### 2.4. Assembling the left/right side of the Smart Farm



- ① Apply glue to the four top corners to fix the Smart Farm's frame.

## 2. Assembling Frame

### 2.5. Completing Smart Farm



- ① When the glue dries, the basic form is completed

## 2. Assembling Frame

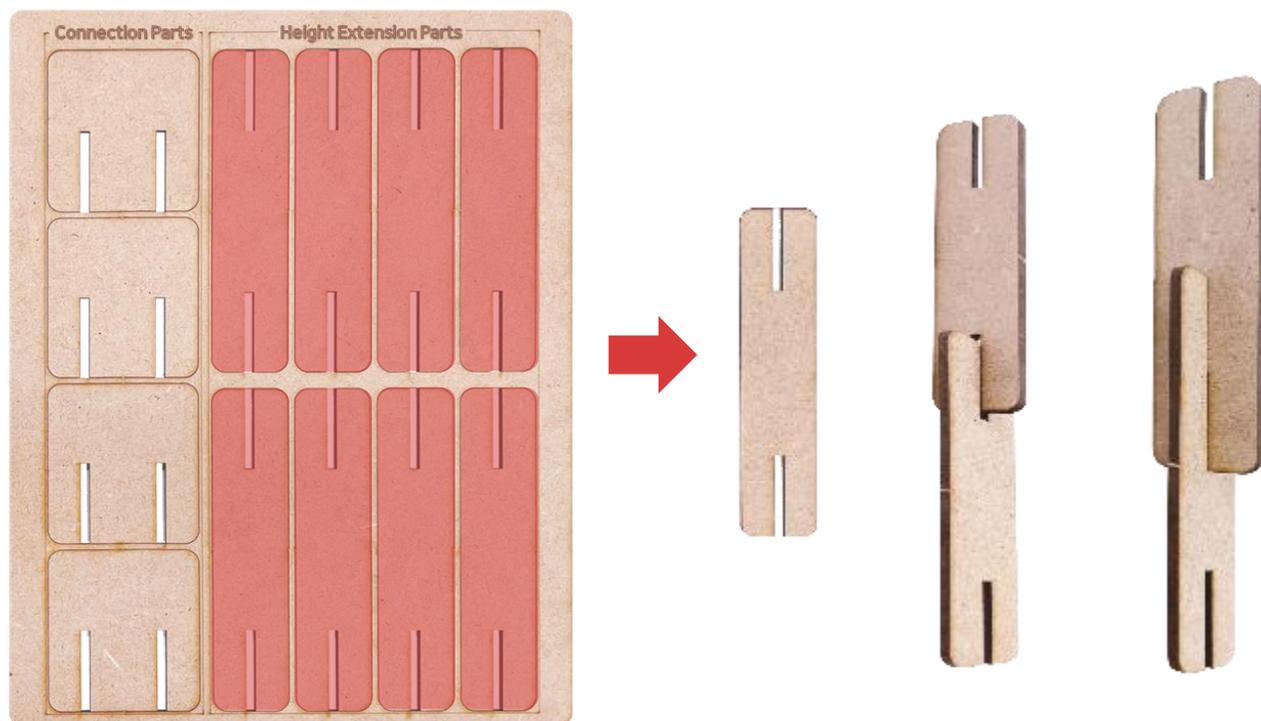
### 2.6. Extended type



- ① Expand the kit using 'Kit connection part' and 'height extension part' among Smart Farm's frames.

## 2. Assembling Frame

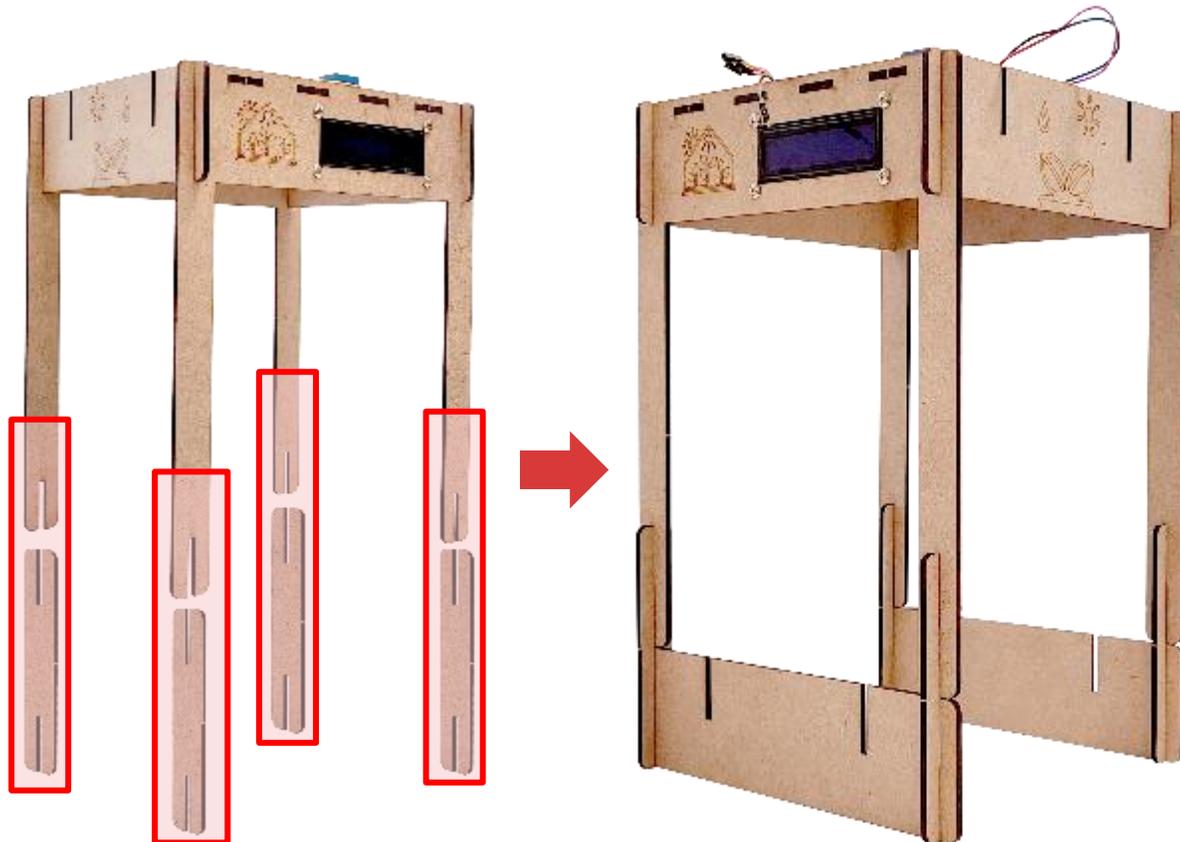
### 2.6. Extended type



- ① Use the 'height extension part' to make expanded legs

## 2. Assembling Frame

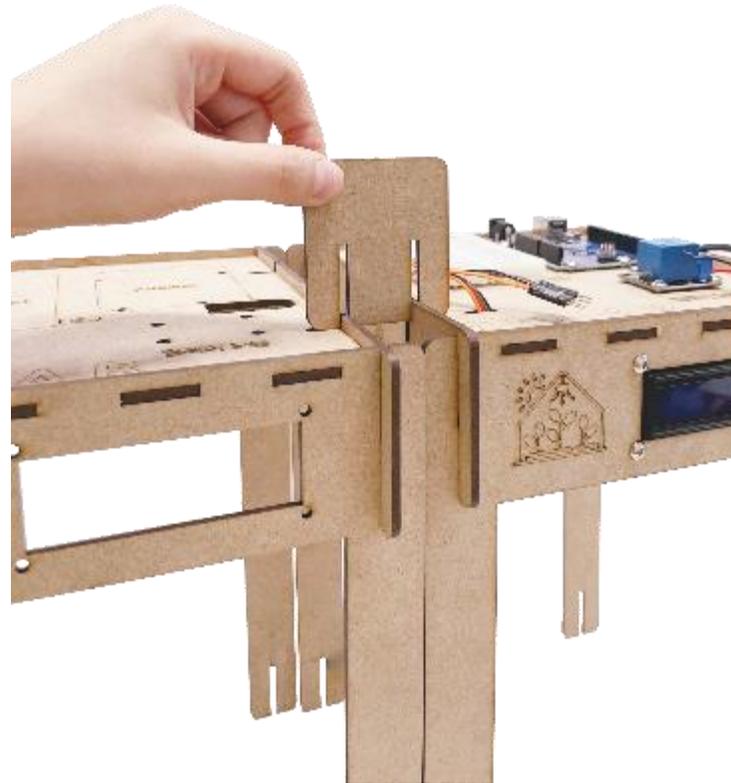
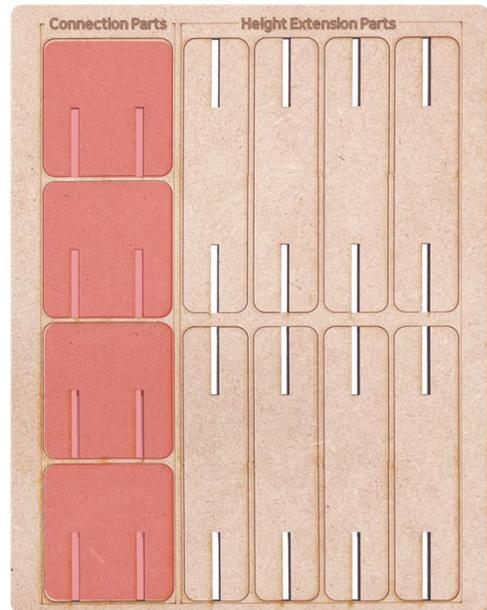
### 2.6. Extended type



- ① Connect the **height extension part** to the Smart Farm's legs at each corner to extend the height.
- ② After extending the legs, connect the support frame to the length extension part.

## 2. Assembling Frame

### 2.6. Extended type



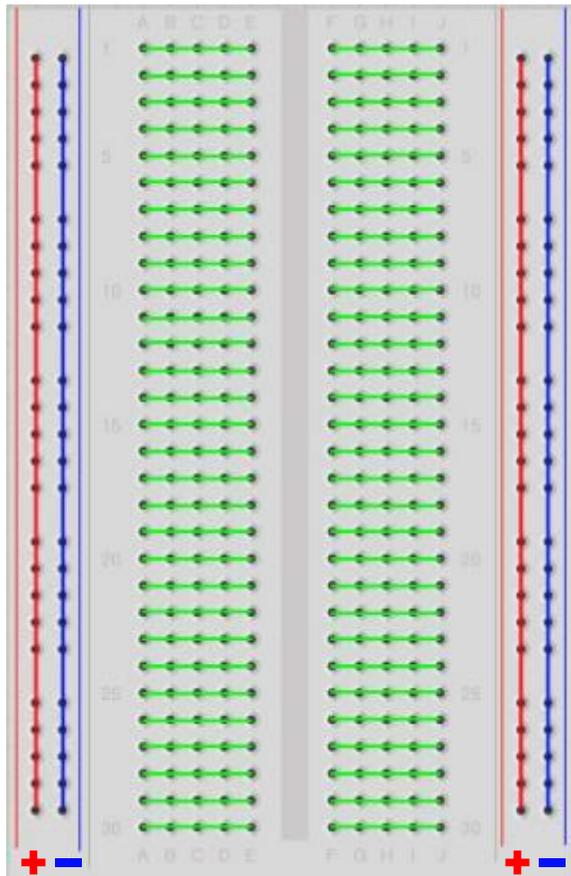
- ① Using **kit connection part**, place the Smart Farm side by side and fit into the grooves on the sides to attach multiple Smart Farms.

# Connecting R3 board with Sensor Module



## 3. Connecting Smart Farm Circuit

### 3.0. Breadboard



① Connect the (-) and (+) poles of the breadboard vertically.

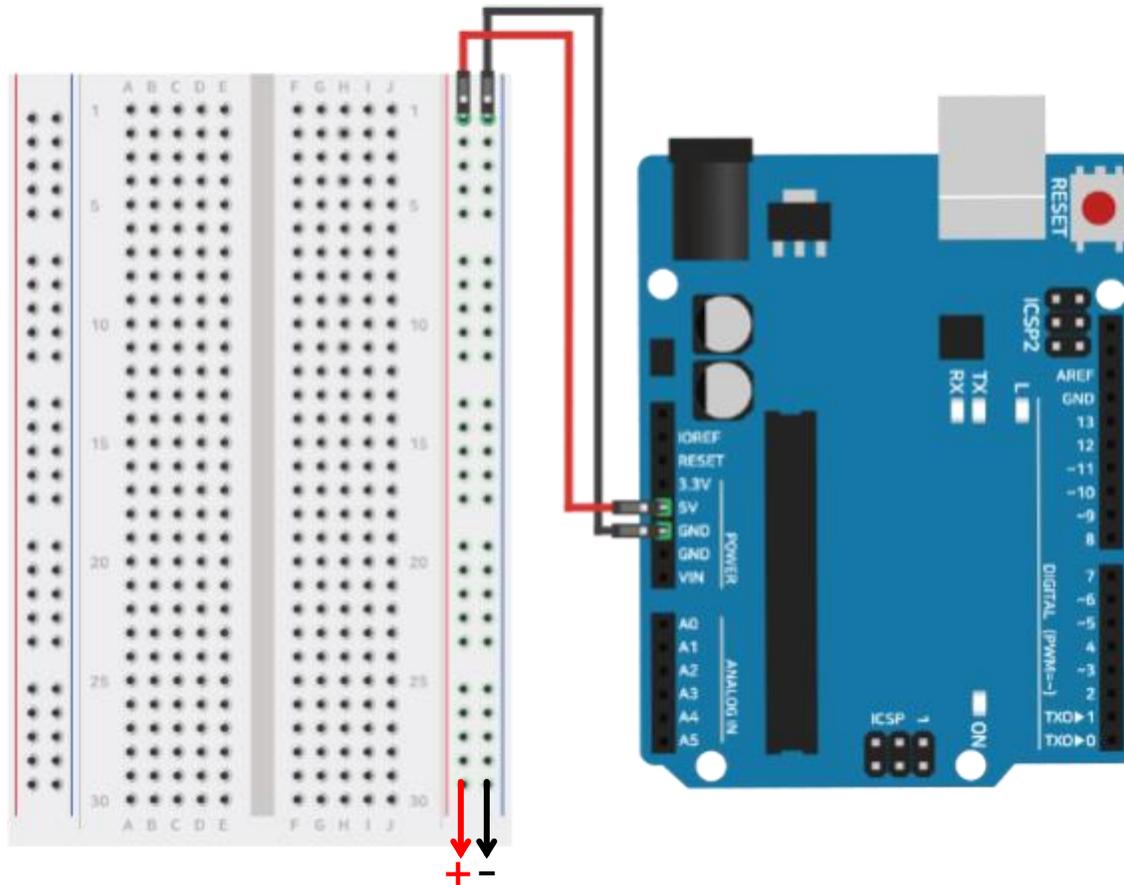
(Red, Blue)

② Connect the rest horizontally.

(Green)

## 3. Connecting Smart Farm Circuit

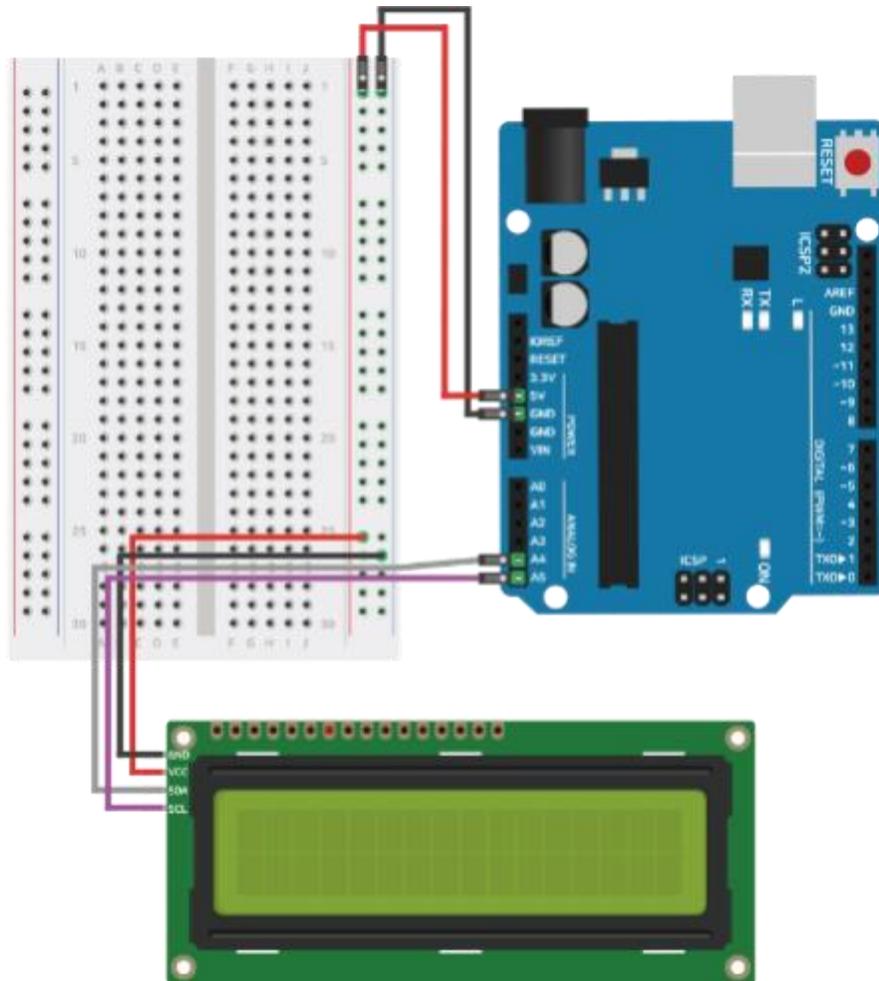
### 3.1. Connecting (-) pole and (+) pole to breadboard



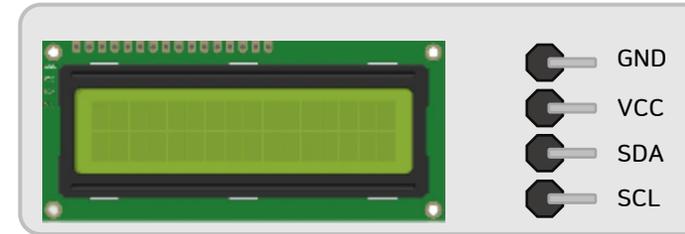
- ① Plug the male jumper wire into the GND of the R3 board and connect the other side to the (-) wire of the Breadboard.
- ② Plug the male jumper wire into 5V of the R3 board and connect the other side to the (+) side of the Breadboard.

## 3. Connecting Smart Farm Circuit

### 3.2. Connecting LCD



※ I2C LCD



① Connect the LCD module and R3 board.

LCD's GND → (-) wire of Breadboard

LCD's VCC → (+) wire of Breadboard

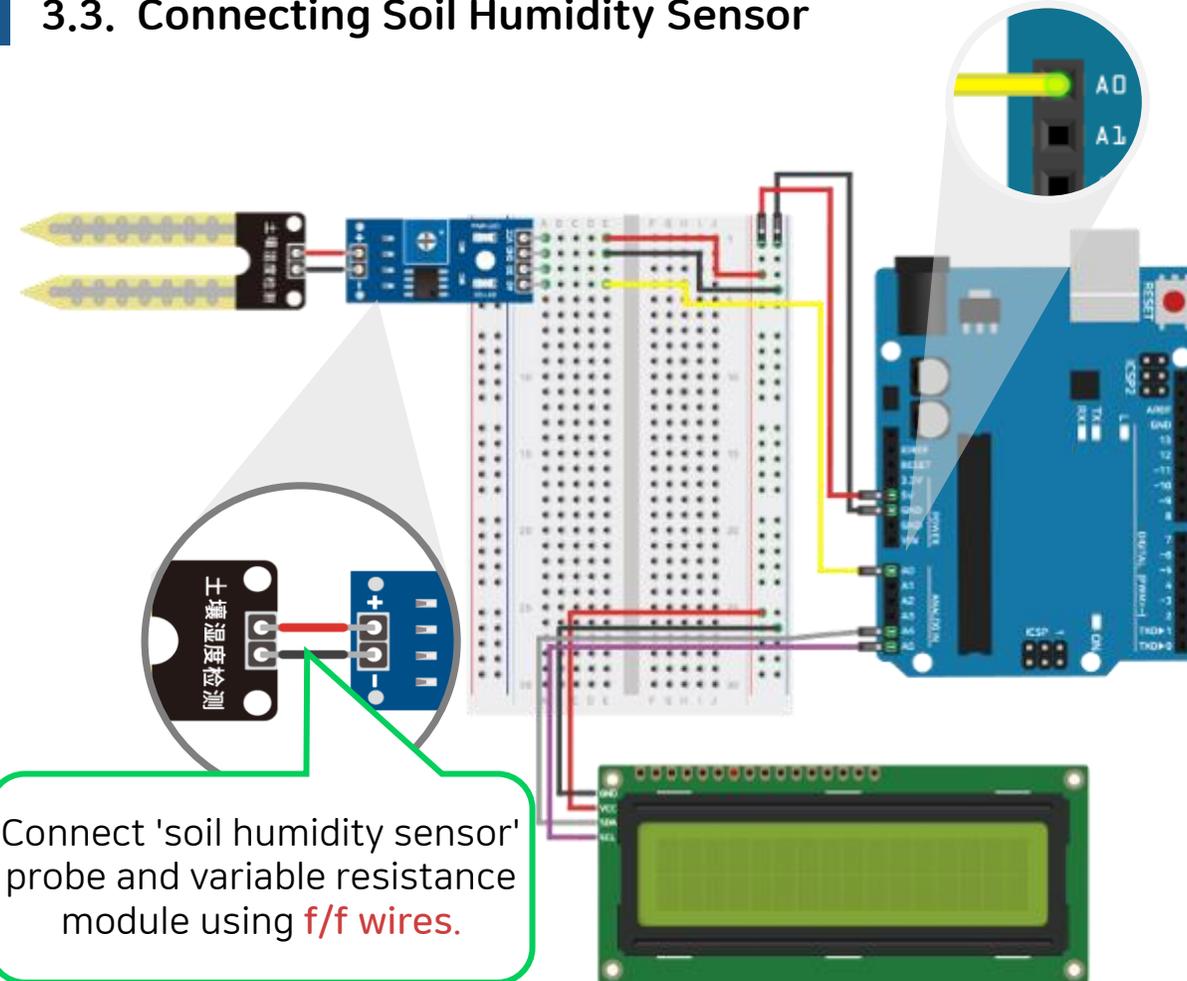
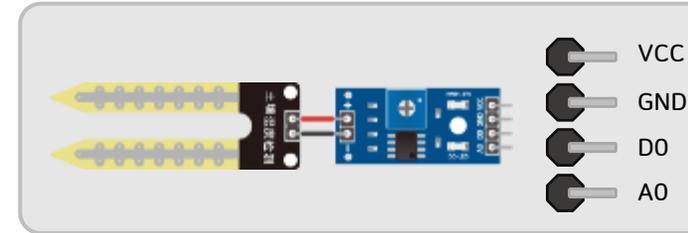
LCD's SDA → A4 pin of R3 board

LCD's SCL → A5 pin of R3 board

### 3. Connecting Smart Farm Circuit

#### 3.3. Connecting Soil Humidity Sensor

※ Soil Humidity Sensor



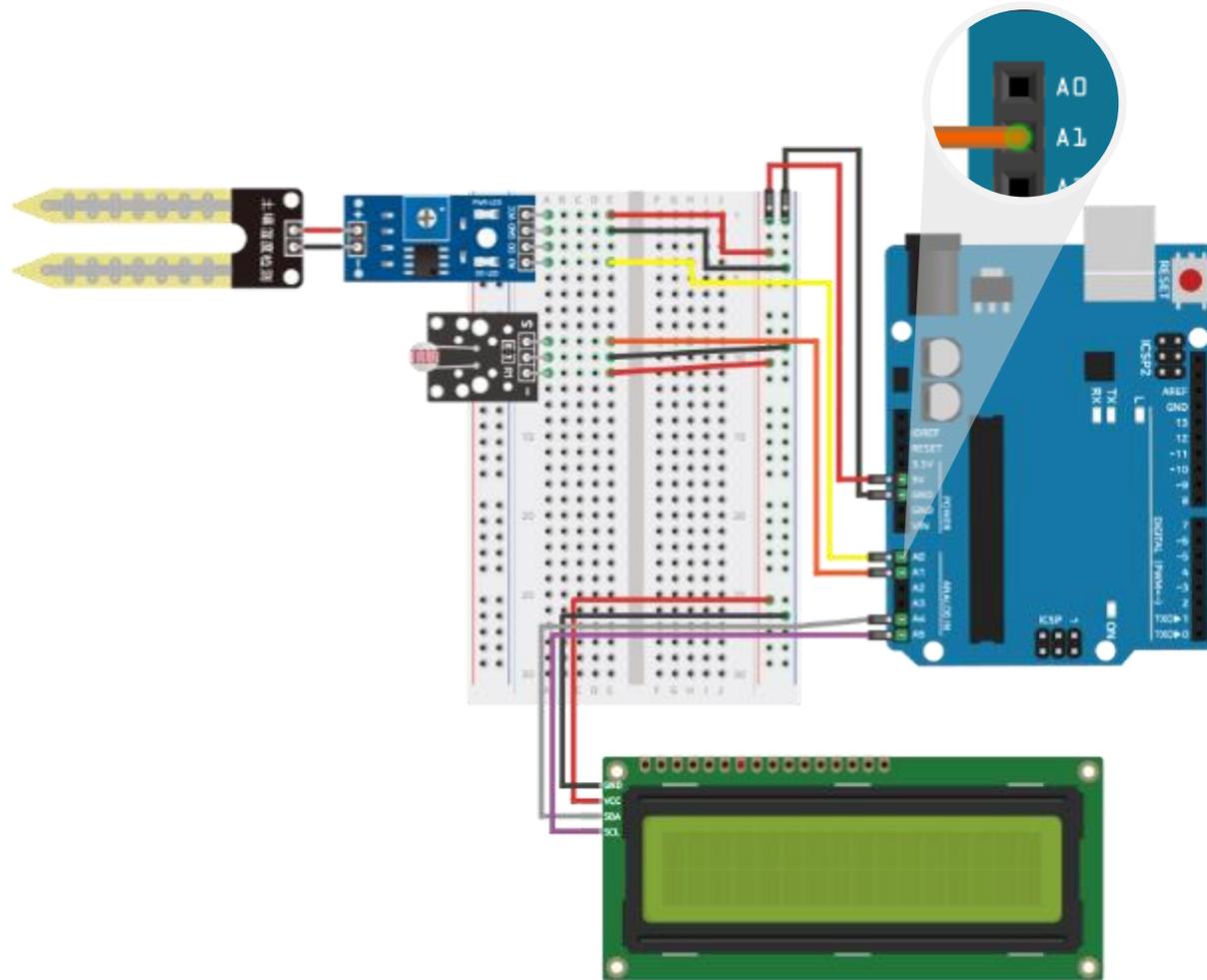
Connect 'soil humidity sensor' probe and variable resistance module using **f/f wires**.

- ① After **directly connecting** the Soil Humidity Sensor module to the breadboard, connect it to the R3 board using a jumper wire.

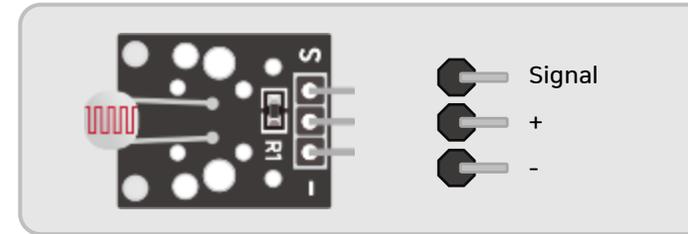
Soil Humidity Sensor's VCC → Breadboard's (+) wire  
Soil Humidity Sensor's GND → Breadboard's -wire  
Soil Humidity Sensor's AO → R3 board's A0 pin

### 3. Connecting Smart Farm Circuit

#### 3.4. Connecting Photoresistor



※ Photoresistor

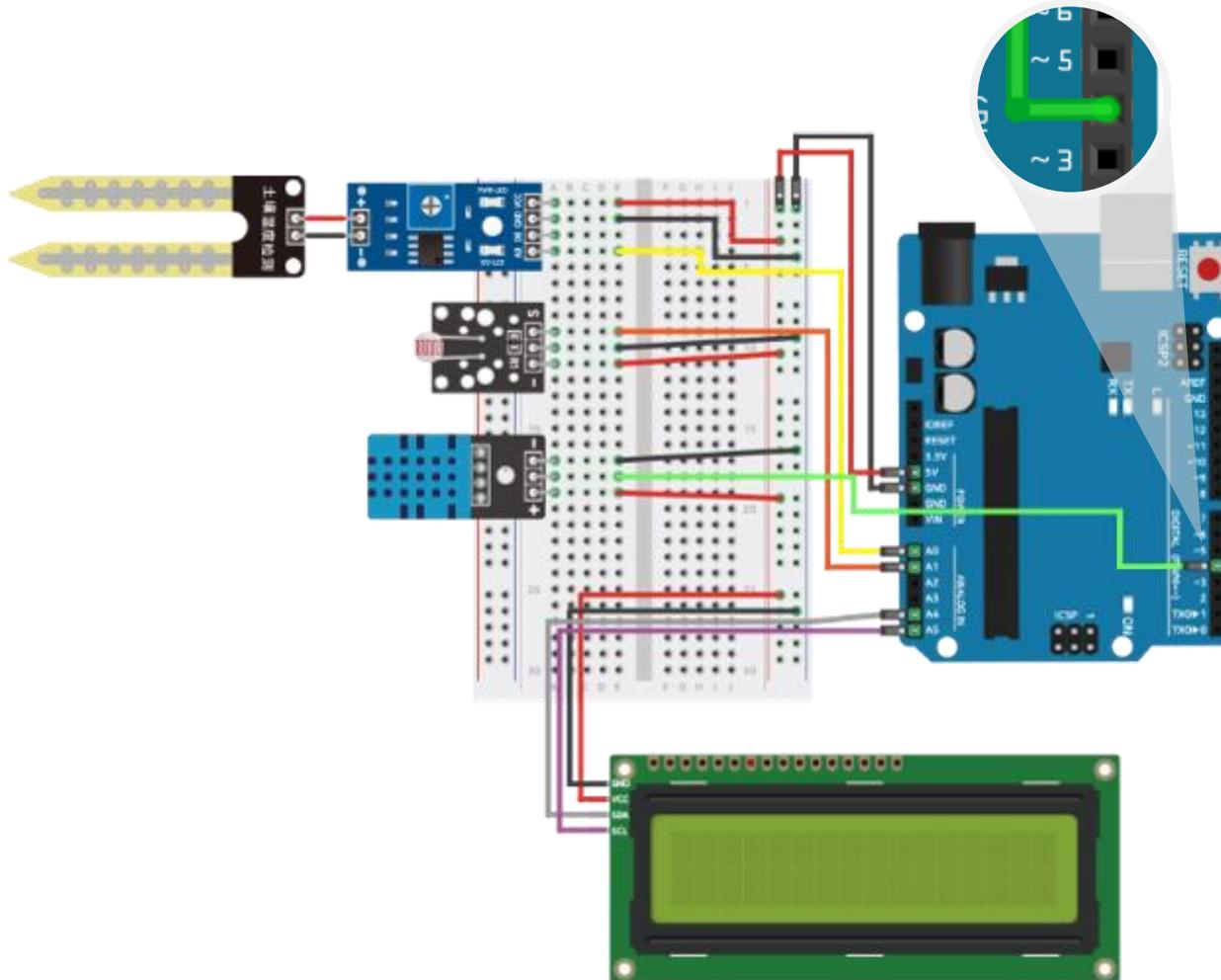


- ① After **directly connecting** the Photoresistor Sensor to the breadboard, connect it to the R3 board using a jumper wire.

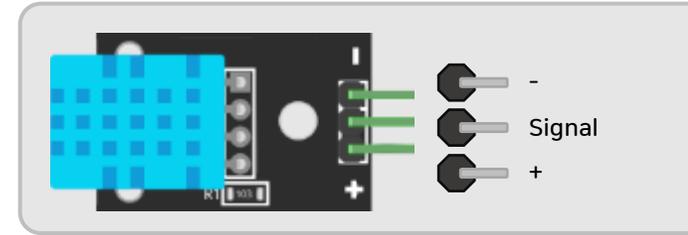
Photoresistor's S pin → R3 board's A1 pin  
Photoresistor's + pin → Breadboard's (+) wire  
Photoresistor's - pin → Breadboard's (-) wire

### 3. Connecting Smart Farm Circuit

#### 3.5. Connecting temperature-humidity sensor



※ Temperature-humidity sensor



- ① After directly connecting the temperature-humidity sensor to the breadboard, connect it to the R3 board using a jumper wire.

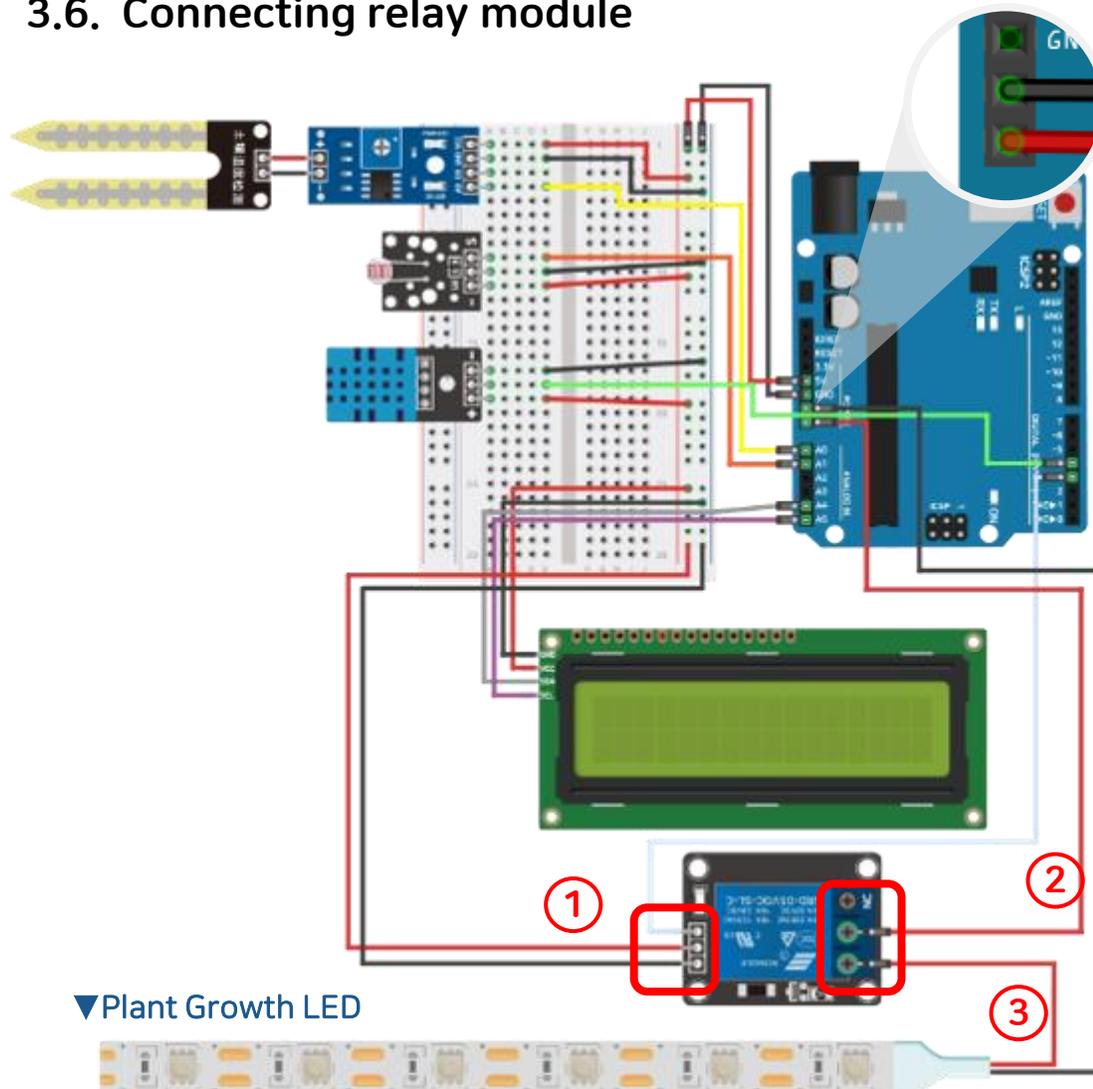
Temperature-humidity sensor's - pin → Breadboard's (-) wire

Temperature-humidity sensor's S pin → R3 board's 4 pin

Temperature-humidity sensor's + pin → Breadboard's (+) wire

### 3. Connecting Smart Farm Circuit

#### 3.6. Connecting relay module



▼ Plant Growth LED

※ Relay module



- ① Connect the **left** pin of the relay module to the Breadboard and R3 board first.

Relay module's S pin → R3 board's 3 pin

Relay module's (+) pin → Breadboard's (+) wire

Relay module's (-) pin → Breadboard's (-) wire

- ② Connect the **right** pin of the relay module to the R3 board.

Relay module's COM pin → R3 board's VIN pin

- ③ Among the **screws on the right side** of the relay module, **unscrew** the NO pin screw, **insert** the red jumper wire of the LED, and **tighten** the screw to fix it.

Connect a jumper wire of the plant growth LED to the R3 board.

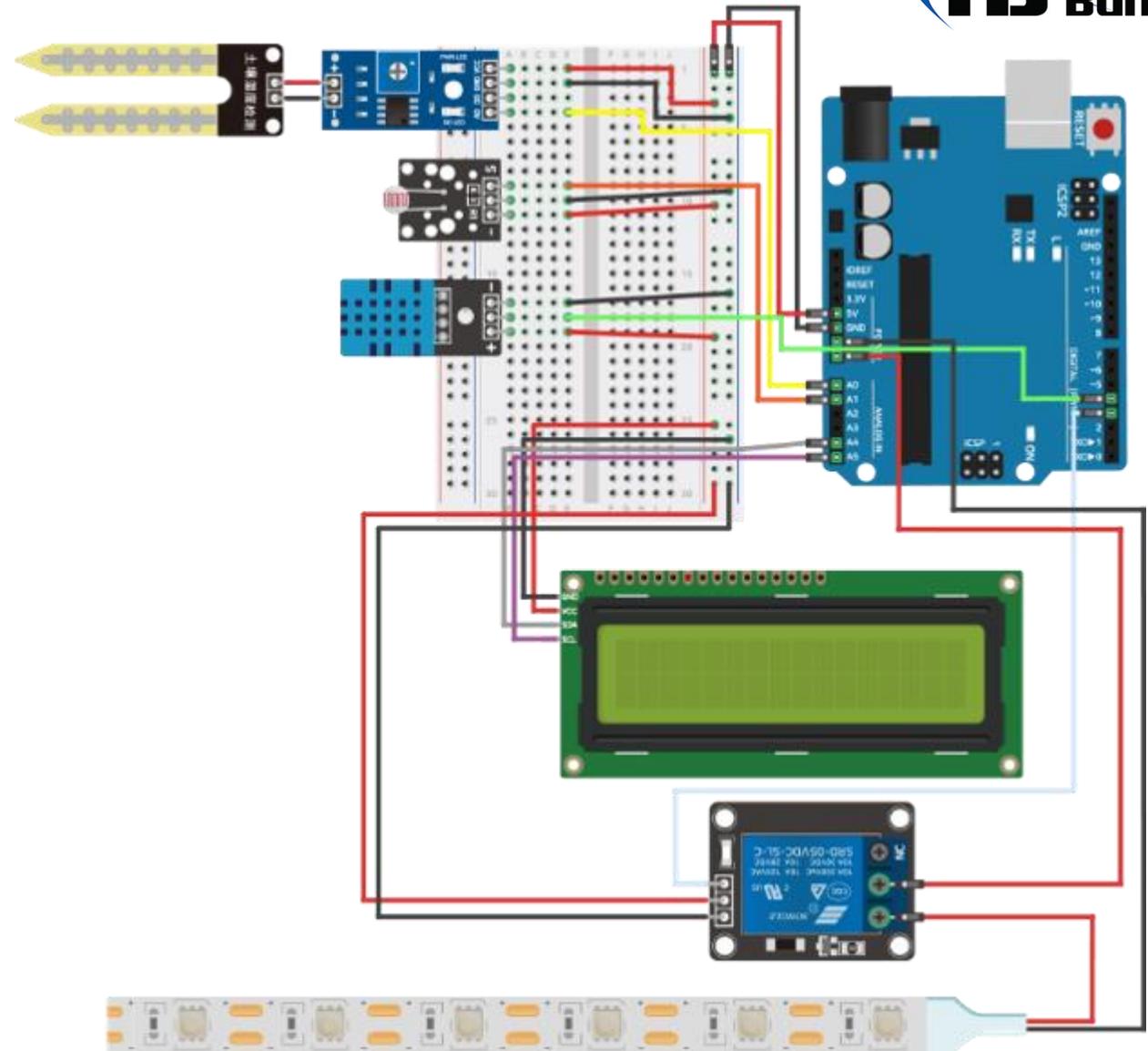
Plant Growth LED's Jumper wire → R3 board's GND pin

### 3. Connecting Smart Farm Circuit

#### 3.7. Completed circuit diagram

##### \* Notice

When making modifications to the circuit, make sure to disconnect the power source (USB cable or adapter) connected to the board.



# Preparing the environment for **Arduino IDE**



## 4. Preparing the development environment

### 4.1. Installing Arduino IDE

- Access [<https://www.arduino.cc/en/main/software>]
- Download the Arduino IDE for Window.



The screenshot shows the Arduino website's 'Legacy IDE (1.8.X)' page. The navigation bar includes 'PROFESSIONAL', 'EDUCATION', 'STORE', 'SIGN IN', 'HARDWARE', 'SOFTWARE' (highlighted), 'CLOUD', 'DOCUMENTATION', 'COMMUNITY', and 'BLOG'. The main content area features the Arduino logo and the text 'Arduino IDE 1.8.19'. A description states: 'The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. This software can be used with any Arduino board. Refer to the [Getting Started](#) page for Installation instructions.' Below this, it mentions 'SOURCE CODE' and that active development is 'hosted by GitHub'. The 'DOWNLOAD OPTIONS' section lists: 'Windows Win 7 and newer' (highlighted with a red box and mouse cursor), 'Windows ZIP file', 'Windows app Win 8.1 or 10' (with a 'Get' button), 'Linux 32 bits', 'Linux 64 bits', 'Linux ARM 32 bits', 'Linux ARM 64 bits', 'Mac OS X 10.10 or newer', 'Release Notes', and 'Checksums (sha512)'.

## 4. Preparing the development environment

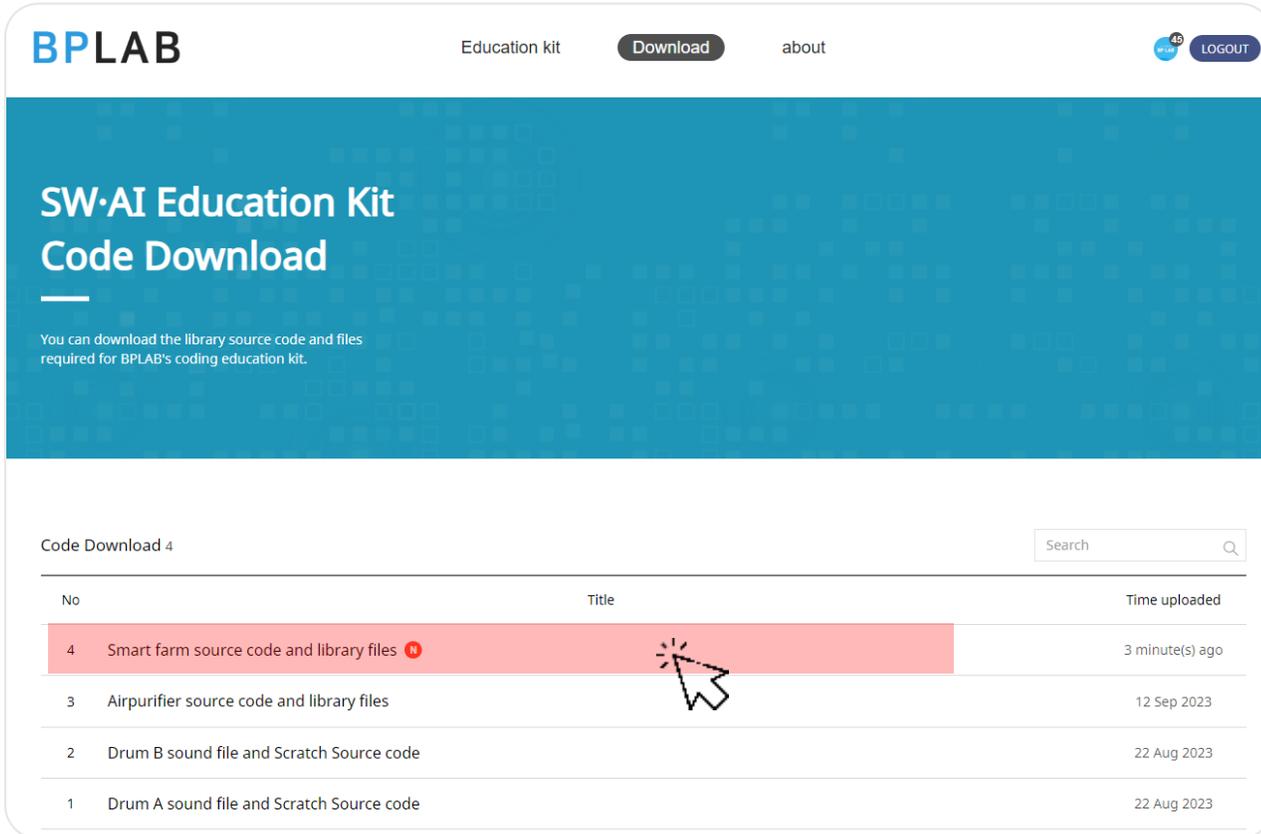
### 4.1. Installing Arduino IDE

- Click **JUST DOWNLOAD**
- Run [.exe file] and install the program.



## 4. Preparing the development environment

### 4.2. Installing CH340 Driver



**BPLAB** Education kit **Download** about **LOGOUT**

## SW·AI Education Kit Code Download

You can download the library source code and files required for BPLAB's coding education kit.

Code Download 4

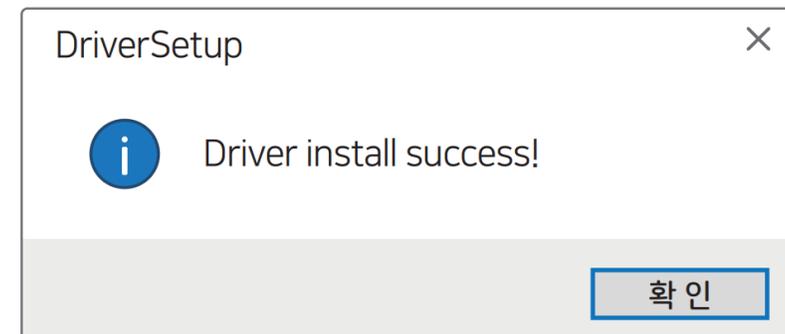
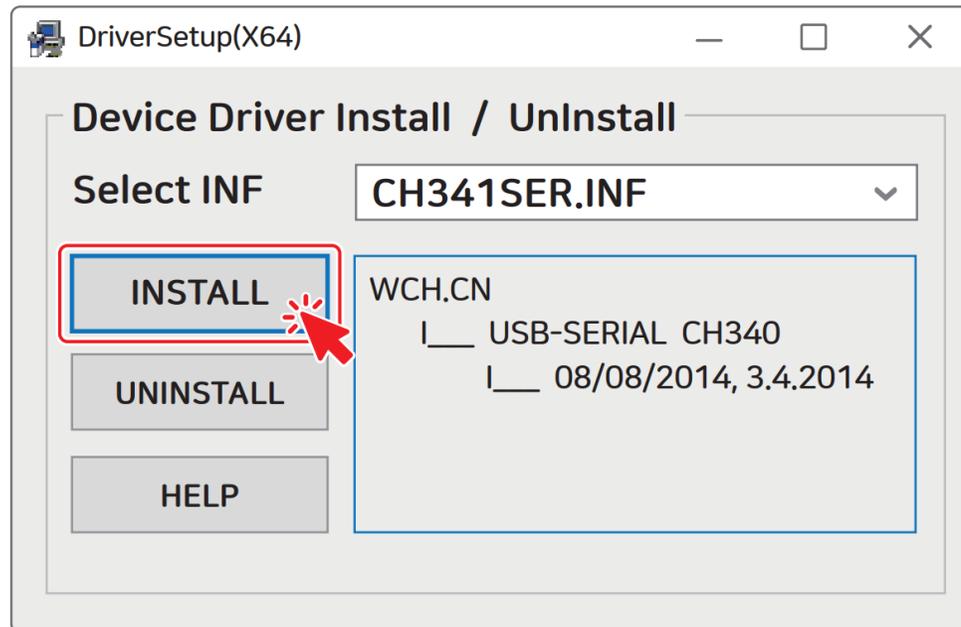
No	Title	Time uploaded
4	Smart farm source code and library files	3 minute(s) ago
3	Airpurifier source code and library files	12 Sep 2023
2	Drum B sound file and Scratch Source code	22 Aug 2023
1	Drum A sound file and Scratch Source code	22 Aug 2023

- ① Go to <https://www.hamiltonbuhl.com/teacher-resource>
- ② Click the **Smart Farm LED GrowLight System with Arduino** link.
- ③ Click on the **relevant driver needed for your device.**

## 4. Preparing the development environment

### 4.2. Installing CH340 Driver

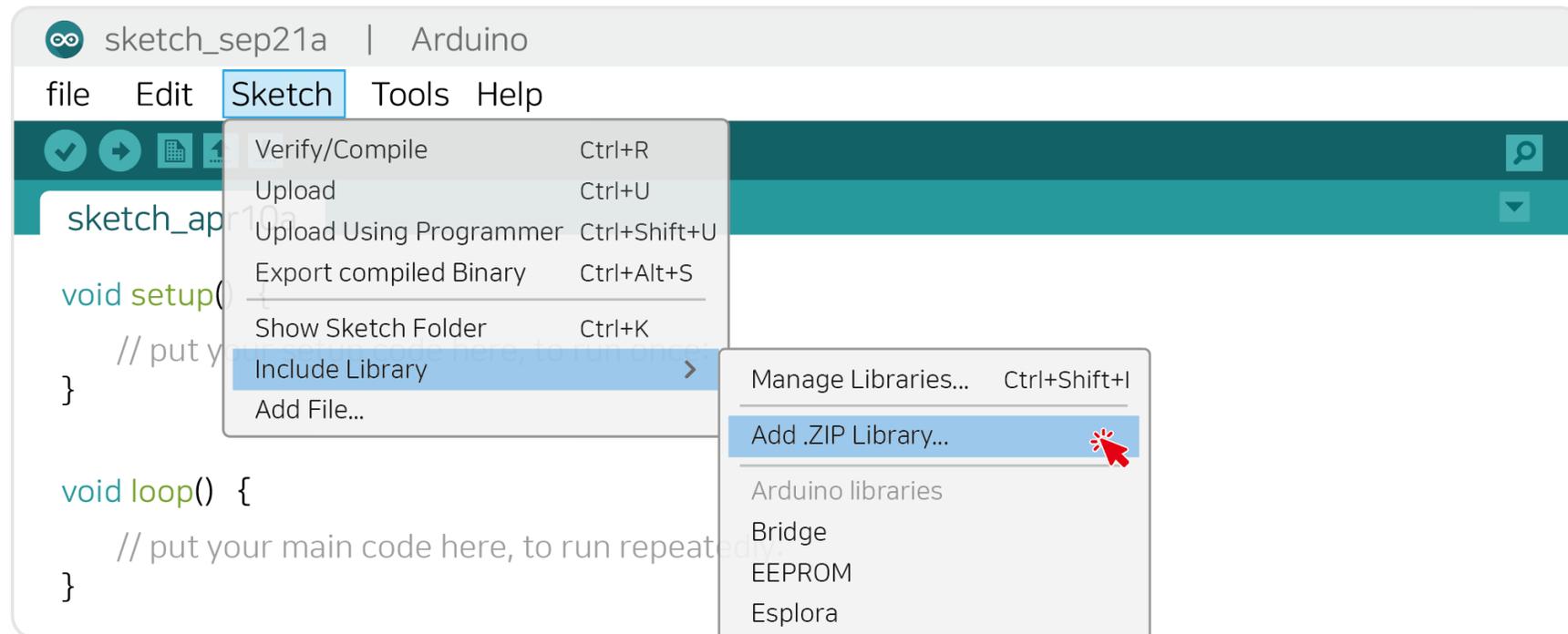
- Download the Driver `CH34x_Install_Windows_v3_4.EXE` 
- "Run the .exe and click the **INSTALL** button to install the driver.



## 4. Preparing the development environment

### 4.3. Installing sensor Library

- Download the files `DHT.zip` `Emotion.zip` `LiquidCrystal_I2C.zip`
- Do not unzip the zipped file. After running Arduino IDE, on the top menu [Sketch → Include Libraries → Add .ZIP Library].



## 4. Preparing the development environment

### 4.4. Compiling smart farm Source Code

- Download the files `smart_farm.ino` 
- Run the .ino file and If a notification window like "Do you want to move the file?" pops up, select "OK"



```
smart_farm | Arduino 1.8.19
File Edit Sketch Tools Help
smart_farm
#include <Wire.h>
#include <LiquidCrystal_I2C.h> // LCD 모듈 라이브러리
#include <DHT.h> // 온습도 센서 모듈 라이브러리
#include <Emotion_Farm.h> // 특수 문자 및 이모티콘 라이브러리

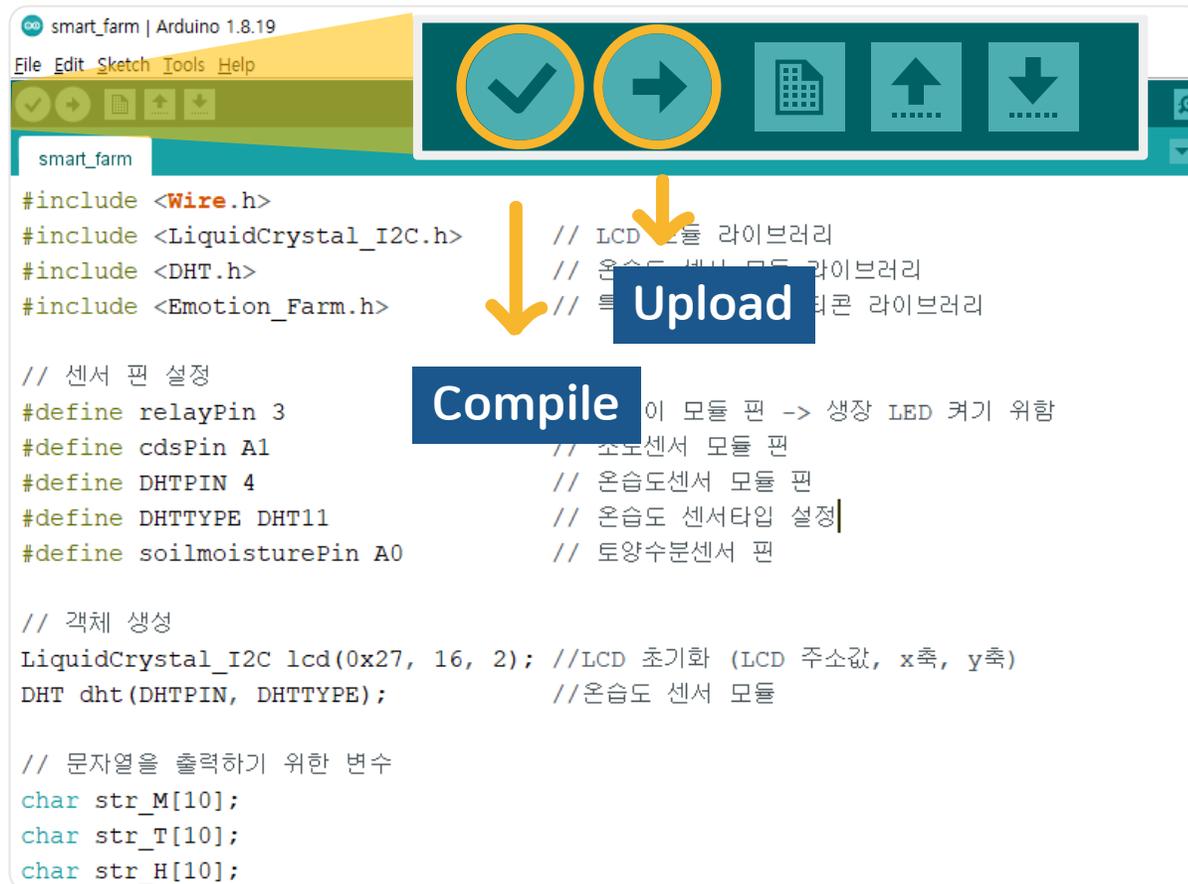
// 센서 핀 설정
#define relayPin 3 // 릴레이 모듈 핀 -> 생장 LED 켜기 위함
#define cdsPin A1 // 조도센서 모듈 핀
#define DHTPIN 4 // 온습도센서 모듈 핀
#define DHTTYPE DHT11 // 온습도 센서타입 설정
#define soilmoisturePin A0 // 토양수분센서 핀

// 객체 생성
LiquidCrystal_I2C lcd(0x27, 16, 2); //LCD 초기화 (LCD 주소값, x축, y축)
DHT dht(DHTPIN, DHTTYPE); //온습도 센서 모듈

// 문자열을 출력하기 위한 변수
char str_M[10];
char str_T[10];
char str_H[10];
```

## 4. Preparing the development environment

### 4.4. Compiling smart farm Source Code



```
smart_farm | Arduino 1.8.19
File Edit Sketch Tools Help
smart_farm
#include <Wire.h>
#include <LiquidCrystal_I2C.h> // LCD 모듈 라이브러리
#include <DHT.h> // 온습도 센서 모듈 라이브러리
#include <Emotion_Farm.h> // 특이한 아이콘 라이브러리

// 센서 핀 설정
#define relayPin 3 // 이 모듈 핀 -> 생장 LED 켜기 위함
#define cdsPin A1 // 조도센서 모듈 핀
#define DHTPIN 4 // 온습도센서 모듈 핀
#define DHTTYPE DHT11 // 온습도 센서타입 설정
#define soilmoisturePin A0 // 토양수분센서 핀

// 객체 생성
LiquidCrystal_I2C lcd(0x27, 16, 2); //LCD 초기화 (LCD 주소값, x축, y축)
DHT dht(DHTPIN, DHTTYPE); //온습도 센서 모듈

// 문자열을 출력하기 위한 변수
char str_M[10];
char str_T[10];
char str_H[10];
```

- ① You can check for errors in the source code with the 'Compile ' button.
- ② Use the 'Upload ' button to upload the source code to the R3 board.

# Smart Farm

## Source Code



## 5. Smart Farm Source Code

### 5.1. Adding library and setting variables

```
smart_farm_test

① #include <Wire.h>
#include <LiquidCrystal_I2C.h>
#include <DHT.h>
#include <Emotion_Farm.h>

② //Sensors
#define relayPin 3
#define cdsPin A1
#define DHTPIN 4
#define DHTTYPE DHT11
#define soilmoisturePin A0

③ //objects creation
LiquidCrystal_I2C lcd(0x27, 16, 2);
DHT dht(DHTPIN, DHTTYPE);

④ //variables to output a string
char str_M[10];
char str_T[10];
char str_H[10];
```

- ① Add a library of sensors to use for Smart Farm.
- ② Set the input/output pin of the sensors to be used for parameters.
- ③ The LCD module and the temperature-humidity sensor use the library to create objects.
- ④ Create a string array to output sensor measurements on the LCD.

## 5. Smart Farm Source Code

### 5.2. Setting Input/Output & LCD Initial Value

```
smart_farm_test

void setup() {
  Serial.begin(9600);

  pinMode(relayPin, OUTPUT);
  pinMode(cdsPin, INPUT);
  pinMode(soilmoisturePin, INPUT);

  //print intro on LCD
  lcd.begin();
  lcd.clear();
  lcd.noBacklight();
  delay(500);
  lcd.backlight();
  delay(500);
  lcd.setCursor(2,0);
  lcd.print("SMART");
  delay(1000);
  lcd.setCursor(8,0);
  lcd.print("GARDEN");
  delay(1000);
  lcd.setCursor(0,1);
  lcd.print("BP LAB CodingEdu");
  delay(1000);
  lcd.clear();
}
```

①

```
pinMode(relayPin, OUTPUT);
pinMode(cdsPin, INPUT);
pinMode(soilmoisturePin, INPUT);
```

②

```
//print intro on LCD
lcd.begin();
lcd.clear();
lcd.noBacklight();
delay(500);
lcd.backlight();
delay(500);
lcd.setCursor(2,0);
lcd.print("SMART");
delay(1000);
lcd.setCursor(8,0);
lcd.print("GARDEN");
delay(1000);
lcd.setCursor(0,1);
lcd.print("BP LAB CodingEdu");
delay(1000);
lcd.clear();
```

- ① Set the serial communication settings and the input and output of sensors within the setup() function.
- ② Display the intro screen of Smart Farm on the LCD.

## 5. Smart Farm Source Code

### 5.3. Declaring special characters

```
smart_farm_test

// Add special characters and emojis added as libraries
lcd.createChar(0, temp);
lcd.createChar(1, C);
lcd.createChar(2, humi);
lcd.createChar(3, Qmark);
lcd.createChar(4, water);
lcd.createChar(5, good);
lcd.createChar(6, wind);
}
```

①

① Assign special characters and emoticons added through the library using the LCD library.  
(Up to 8 possible)

## 5. Smart Farm Source Code

### 5.4. Displaying sensor value measurement & soil humidity value

```
smart_farm_test

void loop() {

  //get sensor values
  int cdsValue = analogRead(cdsPin);
  int soilmoistureValue = analogRead(soilmoisturePin);
  int soilmoisture_per = map(soilmoistureValue, 170, 1023, 100, 0);
  unsigned char h_Value = dht.readHumidity();
  unsigned char t_Value = dht.readTemperature();

  //Output soil moisture value to LCD
  lcd.setCursor(1,0);
  lcd.print("MOIST:");
  sprintf(str_M, "%03d", soilmoisture_per);
  lcd.print(str_M);
  lcd.setCursor(10,0);
  lcd.print("%");
}
```

①

②

- ① In loop(), measure the values of the sensors, and save them in parameters.
- ② To express soil humidity values in %, use the map function to set the range. (Voltage value → Convert to %) Get soil humidity value on LCD.

## 5. Smart Farm Source Code

### 5.5. Displaying temperature/humidity values

```
smart_farm_test

//Display the temperature value to the LCD
lcd.setCursor(1,1);
lcd.write(0);
① sprintf(str_T, "%02d", t_Value);
lcd.setCursor(3,1);
lcd.print(str_T);
lcd.write(1);

//Display the air humidity value to the LCD.
lcd.setCursor(7,1);
lcd.write(2);
② sprintf(str_H, "%02d", h_Value);
lcd.setCursor(9,1);
lcd.print(str_H);
lcd.print("%");
```

- ① Display the temperature value to the LCD.
- ② Display the air humidity value to the LCD.

## 5. Smart Farm Source Code

### 5.6. Growth LED on/off according to the illuminance sensor value

```
smart_farm_test

//Growth LED on/off according to the illuminance sensor value
if(cdsValue < 400){
  digitalWrite(relayPin, LOW);
}
else if(cdsValue >= 400){
  digitalWrite(relayPin, HIGH);
}
```

①

① Using the illumination value being measured, operate the growth LED connected to the relay module.

## 5. Smart Farm Source Code

### 5.7. Emoji display on LCD according to soil humidity value

```
smart_farm_test

//Emoticon displayed on LCD according to soil moisture value
if(soilmoisture_per >= 0 && soilmoisture_per < 30){
  lcd.setCursor(13,0);
  lcd.write(3);
  lcd.setCursor(14,0);
  lcd.write(4);
}

else if(soilmoisture_per >= 30 && soilmoisture_per < 70){
  lcd.setCursor(13,0);
  lcd.print(" ");
  lcd.setCursor(14,0);
  lcd.write(5);
}

else if(soilmoisture_per >= 70){
  lcd.setCursor(13,0);
  lcd.write(3);
  lcd.setCursor(14,0);
  lcd.write(6);
}
Serial.print(cdsValue);
Serial.println(soilmoisture_per);

delay(500);
}
```

①

②

③

- ① Using the humidity value being measured, when the soil humidity is 0% to 30%, an exclamation mark and a water drop emoticons are displayed.
- ② When the soil humidity is between 30% and 70%, a smiling expression is displayed.
- ③ Using the humidity value being measured, when the soil humidity is over 70%, an exclamation mark and a pinwheel emoticons are displayed.