



# Calculating the area of central pivot irrigators

We can use Scratch to create a mathematical model of a field being watered with a central pivot irrigators. This will allow us to work out the area of the field being watered by the irrigator, and the area being missed. When creating mathematical models, we need to define a series of assumptions. This allows us to take our real life situation and create a comparable system in Scratch. Here our assumptions will be:

- That the field is flat
- That we cannot cross the field boundary
- That the field is perfectly rectangular
- That the central pivot irrigator has been installed in the centre of the field
- That the area reached by the irrigator is a perfect circle

To calculate the area of a field watered by a central pivot irrigator, we need to calculate the difference between the area of the field and the area of the circle watered by the irrigator.

First, let's calculate the area of the field. We will need a block to start our program. Find the 'when flag clicked' block from Events.

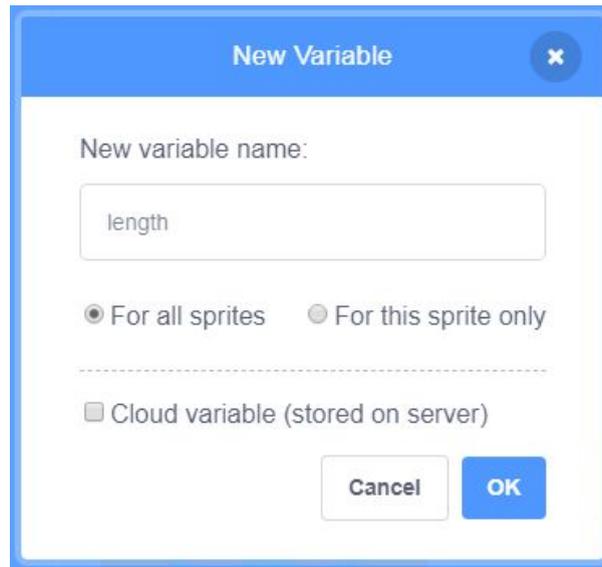


The 'Ask \_\_\_ and wait' block from Sensing allows the user to input information that can be used in the program. We can use this block to find out from the user how big the field is.



We need to store this information so we can recall and use it later. For this, we can use a variable. Variables are used to store pieces of information in digital devices. They are a storage location represented symbolically and used to hold a piece of information such as a number or a name.

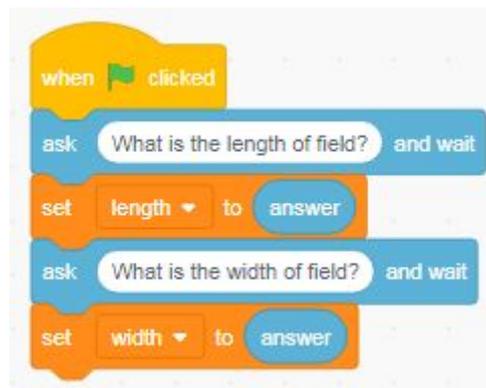
Head into Variables and click 'Make a Variable'. Create a new variable called 'length.'



Once you have created your variable, set it to the answer given by the user.



Repeat the process with the width of the field.



The next step will be calculating the area of the field, which is equal to the width multiplied by the length.

$$\text{Area} = \text{length} * \text{width}$$

Create a new variable in which we can save the area of the field. Using the multiplication block from Operators, set your new variable to the field width multiplied by the length. We can get the cat sprite to tell us the area of the field using a say block from Looks and a join block from Operators.

```

when clicked
ask "What is the length of field?" and wait
set length to answer
ask "What is the width of field?" and wait
set width to answer
set field_area to length * width
say join "The area of field is " field_area for 2 seconds

```

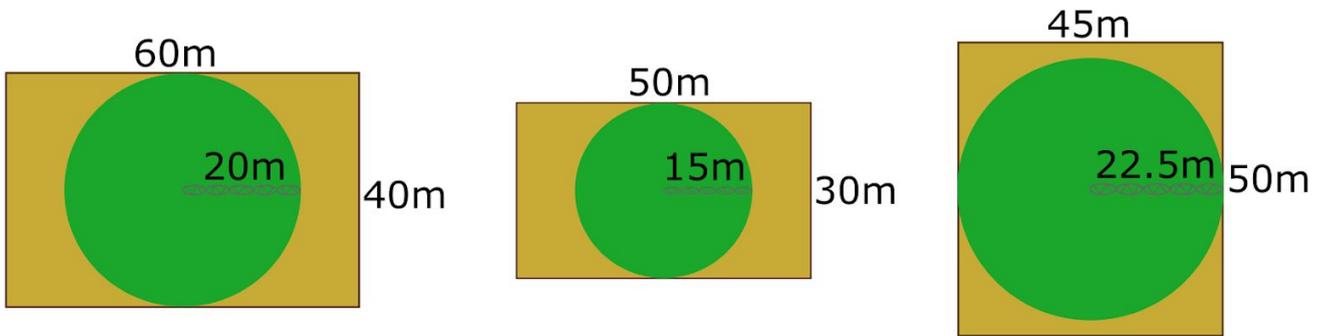
```

length 6
width 4
field_area 24

```



The next step is to decide on the radius of the central pivot irrigator. Using our previously defined assumptions, we know that the biggest diameter of the circle being watered will be the smallest dimension of the field. The radius will then be half of the smallest dimension of the field.



We need to identify which dimension is smallest. We can do this using an 'if' statement. An 'if' statement is a conditional statement that the computer can use to help it make a decision. Use mathematical blocks from Operators and a new variable to define the radius to be half of the smallest dimension.

```

if length > width then
set radius to width / 2
if length < width then
set radius to length / 2
if length = width then
set radius to length / 2

```

We next need to calculate the area being watered by the irrigator.

As the irrigator waters the field in a perfect circle, the area being watered will be equal to pi multiplied by the radius squared.

$$Area = \pi * r^2 \text{ or } Area = \pi * r * r$$

As Scratch doesn't have pi built in, we will have to define it as a variable and set it manually. When performing mathematical calculations, Scratch gives us six decimal places, so we will define pi to six decimal places, which is 3.1415926. Create a variable to hold the area being irrigated and use two multiplication operators to set it to calculate the area.



```
set pi to 3.1415926
set irrigation_area to pi * radius * radius
```

Finally, we need to find out how much of the field is unwatered. Create another variable and set it to the area of the field minus the area being watered.



```
set unwatered_area to field_area - irrigation_area
```

We can get the cat sprite to tell us the area being watered and the unwatered area using a say block from Looks and a join block from Operators.



```
set irrigation_area to pi * radius * radius
say join The area of irrigation is irrigation_area for 2 seconds
set unwatered_area to field_area - irrigation_area
say join The unwatered area is unwatered_area for 2 seconds
```

## Extension

A circular pattern of irrigation may not be the most efficient way to water a rectangular field. Can you add to your Scratch program so that it can calculate the area of semicircles and quarter circle arcs to find the most efficient way of watering as much of the field as possible? The [BBC website](#) has some advice on how to do this.

