Student:_____  Day:  28/07/2021

Curricular Subject:  Cálculus I

Professor:  Andriceli Richit

## ROTATIONAL GRAZING OF DAIRY CATTLE
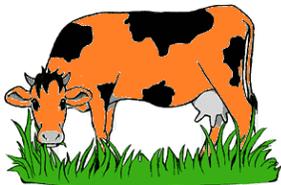
Adapted from *pngwing.*

In the management of dairy cows it is necessary to prepare pastures, which provide abundant and sufficient food for the animals. Generally, these pastures are prepared and divides into paddocks and, in addition, to guarantee the minimum amount of pasture for the animals, each paddock needs to have a minimum size. In the simplest version, the paddocks are built with metalic wires attached to wooden stands as shown in Figure 1.
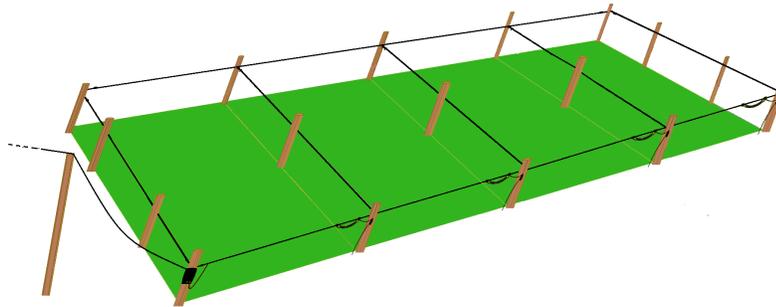


**Figure 1:** Example of a structure for dividing pastures into paddocks.
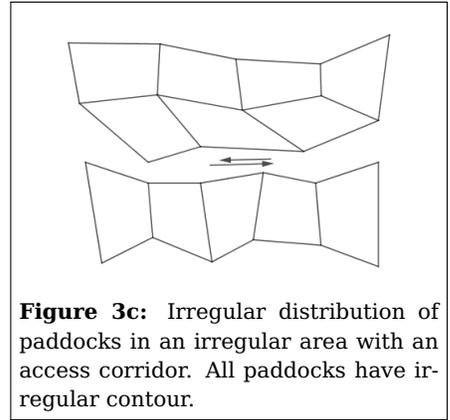
It should also be noted that a minimum number of paddocks is necessary to allow the rotation of animals, as shown in Figure 2. This occurs because pastures need recovery time to become available for grazing again. The number of paddocks needed depends on a number of factors, one of which is the time required for pasture recovery, which in turn depends on other factors such as rainfall, temperature, speed of pasture growth, pasture species, characteristics of the soil, etc.
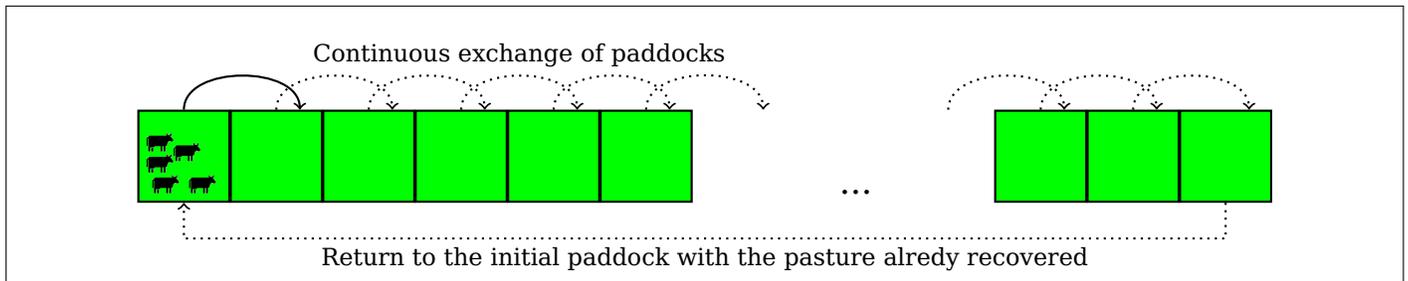


**Figure 2:** Scheme illustrating the continuous rotation of cattle between paddocks.

Thus, in an area used for planting pastures, paddocks can be organized in different layouts and formats, as illustrated in Figure 3.

**Figure 3:** Examples of divisions of the pastures into paddocks.



**Figure 3a:** Regular distribution of paddocks in a rectangular area. All paddocks are rectangular and have the same area.



**Figure 3b:** Irregular distribution of paddocks in an irregular area. All paddocks are rectangular and have the same area.



**Figure 3c:** Irregular distribution of paddocks in an irregular area with an access corridor. All paddocks have irregular contour.
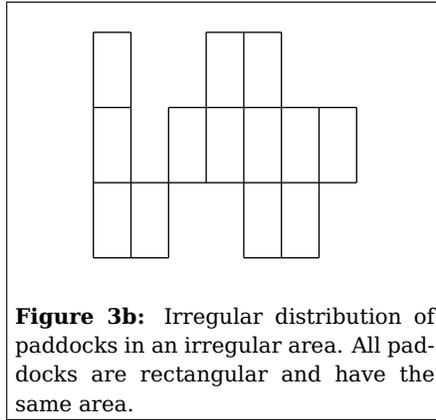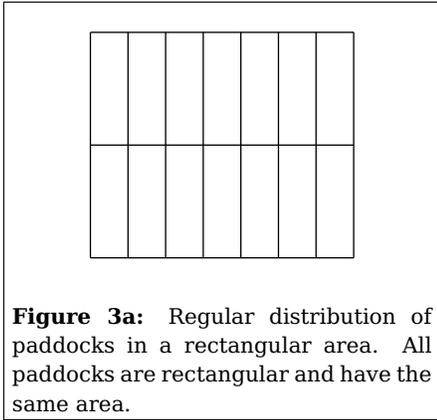
List what you consider necessary for the construction of paddocks in pastures.

_____
_____
_____
_____
_____

Suppose you are helping to plan the division of a pasture into paddocks. Some information is needed..

a)      The first step is to consider the number of animals, as the number of animals influences, for example, the amount of pasture needed and the size of the paddocks.

b)      After defining the number of animals, it is necessary to stipulate the minimum area for each paddock. This measure depends on some factors, such as the consumption of pasture by the managed animals, the type of pasture and the minimum area to ensure animal welfare defined by technical standards.

c)      Another important piece of information is knowing how many paddocks are needed to carry out continuous rotation for the number of animals considered.

d)      Having established the area of each paddock and the number of paddocks, the total pasture area required to rotate the animals can be calculated.

e)      After establishing the measurement of the total area, the area of each paddock and the number of paddocks, it is necessary to organize the distribution of paddocks as shown in Figure 3.

All this information is required for planning the paddocks and their distribution according to the delimited area. They represent the necessary basic information: the number of paddocks, the number of animals and the minimum area for the paddocks.

**Statement:** A farmer intends to plan a paddock circuit for 15 dairy cattle. According to technical recommnedations, to ensure the recovery of pastures, the minimum number of paddocks needed is 30, respect an area of 50 $m^2$ per animal per paddock. Suppose that the paddocks configuration addopted in the farm is illustrated in Figure 4.
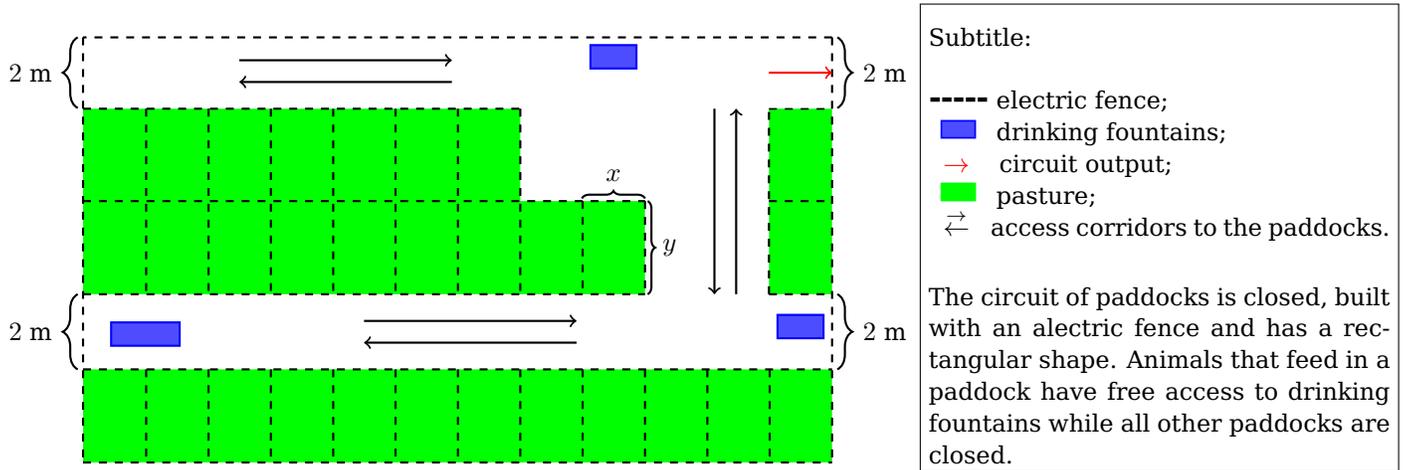


**Figure 4:** Scheme illustrating the circuit with 30 paddocks.

All paddocks are equals and rectangular with $x$ and $y$ measurements in meters. Consider that the paddock circuit is constructed with metalic wires attached to wooden supports as shown in Figure 1. Supposing that the land to be used for grazing is completely flat, that he paddocks are rectangular and that they are organized as shown in Figure 4, determine:

1. The area that each paddock must have under the conditions given by the statement.

2. An expression to calculate the length of wire (perimeter) in meters needed to enclose a rectangular paddock of arbitrary measures $x$ and $y$.

3. An expression that allows you to calculate the total length of wire (in meters) required as a function of the arbitrary measurements of each paddock, for the entire circuit shown in Figure 4.

4. An expression that lets you find the area of just one paddock as a function of th $x$ and $y$ sides.

5. The total length of wire (item 3) as a function of either side $x$ or $y$ of the paddock, maintaining the area stipulated in item 1.

6. What are the $x$ and $y$ dimensions that minimize the total length of wire and maintain the area stipulated in item 1.