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# Sustainability analysis of a rural Nicaraguan coffee cooperative

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A coffee cooperative in the Peñas Blancas region of northern Nicaragua is seeking to evaluate additional revenue streams to offset any losses due to shortcomings in the annual coffee harvest. This module examines multi-faceted aspects of sustainability through analysis of resource allocation, revenue streams, and long-term sustainability for ecotourism development.

A basic model for revenue production  $R$  is the following:

$$R = p \cdot v - k \cdot v - C, \tag{1}$$

$R$  = revenue / day (cordobas / day). Cordobas are the Nicaraguan currency  
 $p$  = visitor charge (cordobas) to stay at the cooperative  
 $v$  = the number of daily visitors (visitors / day)  
 $k$  = daily cost (cordobas / visitor) to accommodate guests  
 $C$  = the fixed costs in the upkeep of the cooperative (cordobas / day) to accommodate visitors.

This module can be implemented in a Calculus course with a variety of topics:

- **Modeling:** What is a reasonable model for the number of daily visitors to the cooperative over the course of the year? What is the minimum price  $p$  that can be set for the cooperative to have a positive revenue?
- **Parameter estimation:** Given a table of items used by visitors and their cost, estimate a value of  $k$  and  $C$  to set the minimum price  $p$  for the cooperative to be profitable.
- **Related rates:** Over the course of a year, how does the Cooperative's daily revenue change according to the number of visitors?
- **Optimization:** Use search engine analytics to determine times of the year the cooperative should aggressively market itself to attract more visitors.
- **Optimization:** What is the level of visitors that maximizes the revenue?
- **Differential equations:** What is a basic model for customer acquisition and how is that translated into the cooperative's revenue?
- **Integration:** What is the annual revenue for the cooperative?

Sample results are shown in the following figures using data provided from the Cooperative. The minimum number of visitors to make the Cooperative profitable ( $R > 0$ ) can be estimated. Additional extensions could include the effect of different pricing schemes and discounts on the Cooperative's revenue.

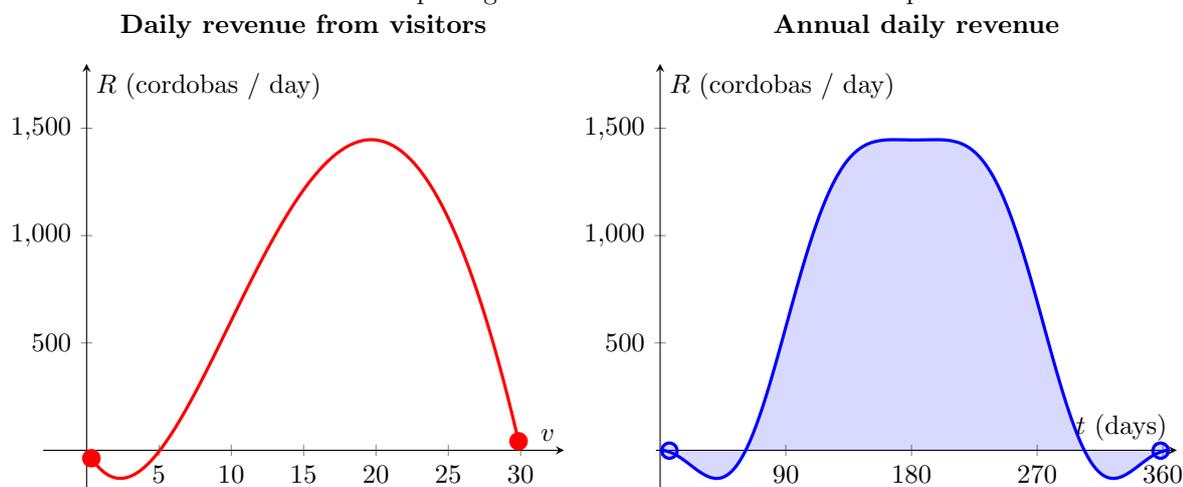


Figure 1: *Left plot:* Dependence of the Cooperative's revenue on the number of daily visitors. *Right plot:* Dependence of the Cooperative's revenue throughout a year, given a conceptual model for the number of visitors.