SPATIAL AND TEMPORAL ANALYSIS OF CATTLE MOVEMENTS IN ARGENTINA

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Introduction

Argentina’s cattle population is 52 million head (Senasa, 2104) which accounts for 70 percent of the animal production (Figure 1). The country is divided into 23 Provinces and one Autonomous District. Provinces are divided into Departments. In Argentina all movements of domestic livestock must be notified to the National Service for Agrifood Health and Quality (SENASA). More than 90 percent of the holdings are georeferenced and cattle identification is mandatory.

Trade is one of the major transmission routes of infectious diseases and movement of live animals is one of the most important ways through which contagious diseases can spread among holdings (1). As a consequence, the evaluation of animal movement networks is of key importance for predicting and controlling the spread of infectious diseases. Characterization of such movements is important in order to establish areas and periods of high risk of introduction and potential spread of disease, as well as new measures to establish surveillance systems and identify farms at risk.

This study aims at temporal-spatial characterization of cattle movements in Argentina in 2012.

Materials and methods

A detailed description of movements from holdings of origin and destination between Provinces and Departments was obtained from data supplied by SENASA Integrated Management System for Animal Health (SIGSA). This information includes frequency number of animals, types of movement, geographic coordinates, date of movement (day and month) and the National Register of Agricultural Producers (Renspa).

The description and analysis of movements and spatiotemporal patterns were performed using the methodology of network analysis algorithms and graph theory by R Language v2.10.1 with igraph library. The descriptive analysis was performed using graphs with Excel (12.0) and the maps were created by ArcGIS version 9.3 (ESRI) software.

The distance of each movement was estimated through the Euclidean distance between the coordinates of each node.

Results and conclusions

In 2012, a total of 1.1 million movements involving 27.4 million head of cattle were recorded in the SIGSA database (from holding to holding, from holding to animal market and from holding to slaughterhouse) (Table 1).

When we analyzed holding to holding movements, concentrations of animals were found according to the season, more concentration in autumn (Figure 2). Similar results were observed in previous studies (2). Due to seasonality movements, surveillance could be targeted in different periods in the year.

Movement distances were analyzed, the mean distance was 263 (3.5-1,547) kilometers. From the total number of cattle movements 75 percent traveled up to 391 km and 50 percent up to 210 kilometers (Figure 3).

The results obtained in this study identified areas (Departments) and periods of high risk for the potential introduction and spread of cattle diseases in Argentina (Figure 4).

This type of studies provides support to SENASA to design risk-based surveillance strategies and contingency plans. Moreover, this kind of methodology is particularly interesting in cattle diseases where animal movements are the primary means of disease introduction, and where movement databases are available and updated periodically, like in Argentina. It also offers essential information to include in computer models to simulate the potential disease spread and the potential epidemic size.

<table>
<thead>
<tr>
<th>Movement Type</th>
<th>Total Number of Movements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Holding to Holding</td>
<td>2.4 million</td>
</tr>
<tr>
<td>Holding to Slaughterhouse</td>
<td>1.8 million</td>
</tr>
<tr>
<td>Holding to Animal Market</td>
<td>3.5 million</td>
</tr>
</tbody>
</table>

Table 1. Cattle movements in Argentina from holding to holding, holding to slaughterhouse and holding to animal market.

References


Figure 1. Cattle density in Argentina

Figure 2. Movements from holding to holding by season

Figure 3. Number of movements from holding to holding. Distribution of movement according to distance (km).

Figure 4. Holdings to holding movements. Choropleth maps showing the spatial distribution of departments based on: a) origin, b) destination, c) origin and destination with association, d) origin without association, e) destination without association, f) origin and destination without association.