Preventive Veterinary Medicine 98 (2011) 119–127

Contents lists available at ScienceDirect

Preventive Veterinary Medicine

journal homepage: www.elsevier.com/locate/prevetmed

Analysis of cattle movements in Argentina, 2005

M.N. Aznar[a,*], M.A. Stevenson[b], L. Zarich[c], E.A. León[a]

[a] Área de Epidemiología, CICVyA – INTA, CC 25, 1712, Buenos Aires, Argentina
[b] EpiCentre, Institute of Veterinary, Animal and Biomedical Sciences, Massey University, Private Bag 11-222, Palmerston North, New Zealand
[c] Dirección Nacional de Sanidad Animal, SENASA, C1063ACD, Buenos Aires, Argentina

ARTICLE INFO

Article history:
Received 14 May 2010
Received in revised form 29 October 2010
Accepted 3 November 2010

Keywords:
Movements
Cattle
Social network analysis
Argentina

ABSTRACT

We describe the movement of cattle throughout Argentina in 2005. Details of farm-to-farm and farm-to-slaughter movements of cattle were obtained from the Sanitary Management System database (Sistema de Gestión Sanitaria, SGS), maintained by the National Service for Agrifood Health and Quality (SENASA). Movements were described at the regional and district level in terms of frequency, the number of stock transported, the district of origin and destination and Euclidean distance traveled. Social network analysis was used to characterize the connections made between regions and districts as a result of cattle movement transactions, and to show how these characteristics might influence disease spread.

Throughout 2005 a total of 1.3 million movement events involving 32 million head of cattle (equivalent to approximately 57% of the national herd) were recorded in the SGS database. The greatest number of farm-to-farm movements occurred from April to June whereas numbers of farm-to-slaughter movement events were relatively constant throughout the year. Throughout 2005 there was a 1.1–1.6-fold increase in the number of farm-to-farm movements of cattle during April–June, compared with other times of the year. District in-degree and out-degree scores varied by season, with higher maximum scores during the autumn and winter compared with summer and spring. Districts with high in-degree scores were concentrated in the Finishing region of the country whereas districts with high out-degree scores were concentrated not only in the Finishing region but also in Mesopotamia, eastern Border and southern Central regions. Although movements of cattle from the Border region tended not to be mediated via markets, the small number of districts in this area with relatively high out-degree scores is a cause for concern as they have the potential to distribute infectious disease widely, in the event of an incursion.

Published by Elsevier B.V.

1. Introduction

Beef production contributes approximately 40% to the national agricultural gross domestic product of Argentina (Rearte, 2007). Throughout the country cattle production is predominantly seasonal: calves are born mostly during the late winter and early spring (July–September) on breeding farms in areas where the quality of soil is relatively poor and pastures are unimproved. After weaning, from March to April, calves are moved to finishing farms in areas with better soil quality and improved pastures. Cattle arrive on finishing farms at around 120–200 kg liveweight and remain there for around 12 months until they are sent to slaughter at 380–450 kg. In addition to steers, older cows, bulls and heifers that are not required for breeding may also be fattened and sent to slaughter (Rearte, 2007). Although cattle are distributed throughout the country, the Central and North eastern regions are the main productive areas

* Corresponding author. Tel.: +54 11 4621 1289.
E-mail address: maznar@cnia.inta.gov.ar (M.N. Aznar).

0167-5877/$ – see front matter. Published by Elsevier B.V.
doi:10.1016/j.prevetmed.2010.11.004

where approximately 90% of the national herd produces greater than 80% of beef for export and domestic consumption.

León et al. (2006) described movements of cattle into and out of two districts in the province of Buenos Aires in 2004. Their analysis showed that the distribution of the number of finishing-related movement events per farm was skewed, with the majority of farms reporting at least 1 and less than 5% of farms reporting greater than 15 finishing related movement events throughout the year. The frequency of finishing movements showed a 1.2–1.8-fold increase from April to September, compared with the rest of the year. While this analysis provides useful insights into the nature of cattle movements in two distinct areas of Buenos Aires province a shortfall of this work relates to the ability to generalize the study findings to other parts of the country. Addressing this issue, in this study we extend the analyses of León et al. (2006) to the entire country. Our objectives were to identify and characterize the pattern of farm-to-farm and farm-to-slaughter cattle movements throughout Argentina in terms of the frequency of movement events, the number of stock moved, the distances traveled and how these varied throughout the year and regionally. A secondary objective was to use social network analysis (Wasserman and Faust, 1994) to characterize connections made between districts as a result of cattle movements, and to show how these characteristics might influence infectious disease spread. Analyses of network structure provide the opportunity to identify targets for interventions, such as control procedures and surveillance (Christley et al., 2005). Since the country is not homogeneous in terms of the risk of receiving or spreading disease, identifying those areas more likely to facilitate the spread of infection via movement provides a more evidence-based approach to the development of risk-based surveillance activities and disease prevention programs. This approach will facilitate more efficient use of resources, particularly in the case of foot-and-mouth disease (FMD), where surveillance strategies to document disease freedom comprise an important component of state veterinary service activity.

2. Materials and methods

2.1. Movement data

In Argentina all movements of domestic livestock must be declared to the state veterinary service (National Service for Agrifood Health and Quality, SENASA). If statutory requirements are met, SENASA allows the movement of identified animals by issuing a permit. The following data are recorded for each movement event: the province and district of origin, the unique identifier of the source farm or market (RENSPA), the date animals are to be transported, the species involved, the number of individuals by age category, the reason for the movement, the province and district of destination and the RENSPA of the destination premise (farm, market or slaughterhouse). These data are recorded by local authorities before being sent to SENASA headquarters where they are stored in a database called the Sanitary Management System (Sistema de Gestión Sanitaria, SGS).

In general, cattle are moved off a farm location to either another farm or slaughterhouse. In both situations these movements may be 'direct' (that is, non-stop from the source to destination) or 'indirect' (where the movement occurs via an animal market). In the majority of situations cattle moved for reasons apart from slaughter are moved for finishing but also, smaller numbers are moved for breeding and reproduction.

The data for this study were derived from the SGS and included records of all cattle movement events that occurred during 2004, 2005 and 2006. Since the three years showed a similar pattern, only details for 2005 are presented.

2.2. The cattle population

The total land area of Argentina, excluding the Antarctic territories, is approximately 2.8 million km^2. The country is divided into a Federal District and 23 primary administrative areas called provinces. Within provinces are secondary administrative areas called 'departamentos' ($n = 506$). For the purpose of this paper these are referred to as 'districts'. Based on factors such as animal density, soil quality and other ecological factors, the 23 provinces are grouped into seven agricultural regions: Central, Cuyo, Border, Finishing, Mesopotamia, North West and Patagonia (Fig. 1).

In 2005 there were approximately 56 million head of cattle in Argentina (6% of which were dairy and 94% beef), maintained within 213,706 farm premises (SENASA, 2008). The Central and Mesopotamia regions contained approximately 90% of the national herd. In 2008 the distribution of cattle by age and gender was as follows: 40% cows, 20% steers, 15% heifers, 23% calves and 2% bulls (SENASA, 2008).

2.3. Data analysis

Data from the SGS were imported into a relational database (Microsoft Access, Microsoft, Redmond, USA). For this study a movement event was defined as the transportation of one or more animals from an identified premise of origin (farm or market) to an identified premise of destination (farm, market or slaughterhouse). In 2005 georeferencing of individual farm locations throughout the country was incomplete and, as a result, it was not possible to provide an analysis of movement events at the individual farm level. For this reason, location has been defined at the district level: movement events that had a destination in the same region (or district) as the source premises were classed as internal; movements outside a region (or district) were classed as external.

The distance of each external movement event was estimated as the Euclidean (straight line) distance between the centroid coordinates of the two districts involved in a given movement transaction. It was not possible to calculate the movement distances for internal movements because the centroids of origin and destination were identical.

Social network analyses were performed on 2005 farm-to-farm movement events using the UCINET software package (UCINET v6.137 Analytic Technologies Inc., Harvard, MA, USA). Analyses were conducted at both the regional and the district level. Counts of movement events