SOCIAL NETWORK ANALYSIS OF POULTRY MOVEMENTS IN ARGENTINA DURING 2009 AND 2010

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INTRODUCTION

The poultry production in Argentina is the second largest industry after the cattle, has an average population of 139 million, and is currently the 6th largest exporter of poultry products (1). For that reason, the potential introduction and spread of exotic diseases affecting poultry such as Newcastle disease, Highly Pathogenic Avian Influenza would have severe socio-economic consequences in the country.
Trade is the one of the main transmission routes of infectious diseases and animal movements is one of the most important ways that contagious animal diseases can spread between holdings (2).
In order to allocate surveillance strategies to prevent and rapid control infectious diseases affecting poultry, the characterization of the structure and contact patters between poultry farms is crucial. However, there are very few studies describing in detail the animal movements between poultry farms and none has explored the contact patterns in Argentina.
The study presented here is aimed to describe in detail the structure and the trade flows among the poultry farms in Argentina using Social Network Analysis (SNA) and graph theory.

MATERIALS AND METHODS

Data on poultry farms (i.e. census, location, biosecurity, type of production) and poultry movements (i.e. date of movement, species involved, number of birds moved) from January 2009 to December 2010 were obtained from the National Service for Agrifood Health and Quality (SENASA).
The poultry directed network was constructed using poultry farms as nodes and poultry movements between farms as links. SNA metrics were used to describe the poultry network in Argentina.
Degree and closeness centrality measures were computed to identify "important" nodes that may be at particular high risk for disease introduction and spread.
Analyses were performed using R Language v2.10.1 with igraph library and network was visualized using Arc GIS 9.3 (ESRI).

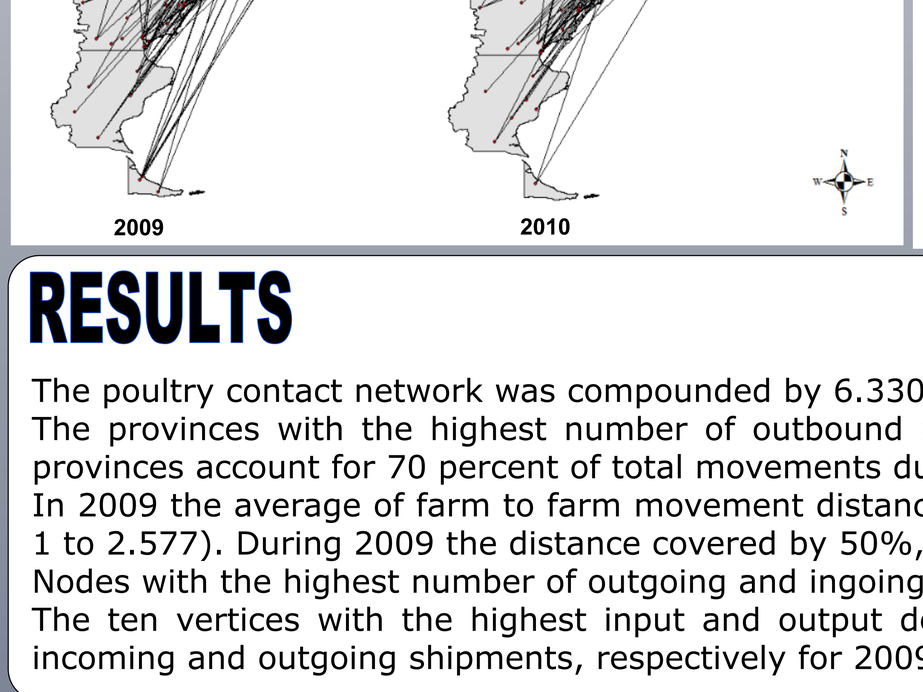


Figure 3 . Complete network of poultry movements, farm-to-farm, in Argentina during 2009 and 2010

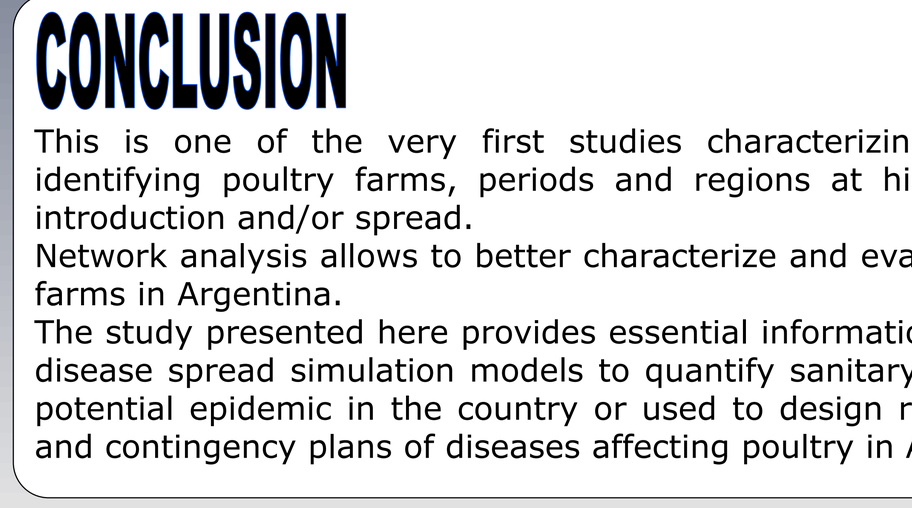


Figure 1 : Location of poultry farms of Argentina

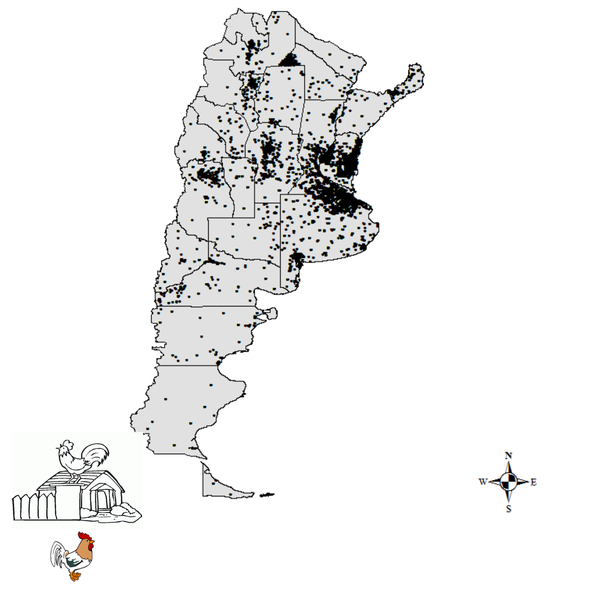


Figure 2. Description of the network and centrality measures

PARAMETER	2009	2010
NETWORK SIZE		
Number of nodes	6630	6458
Number of direct links	50374	50566
MEASURES OF CENTRALITY		
Median in-degree (range)	5 (0-804)	5 (0-802)
Median out-degree (range)	0 (0-2841)	0 (0-2747)
Median in-closeness (range)	0.98048 (0.9998-1.0173)	1.00031 (0.99984-1.0207)
Median out-closeness (range)	0.98002 (0.9998-1.7503)	0.99984 (0.99984-1.5590)

Figure 4. Indegree and outdegree 2009 and 2010 by type of production (1.Others productions, 2.Backyard poultry, 3.Hatchery , 4.Meat production, 5.Meat and egg production, 6.Egg production, 7. Breeders, 8.Not determined)

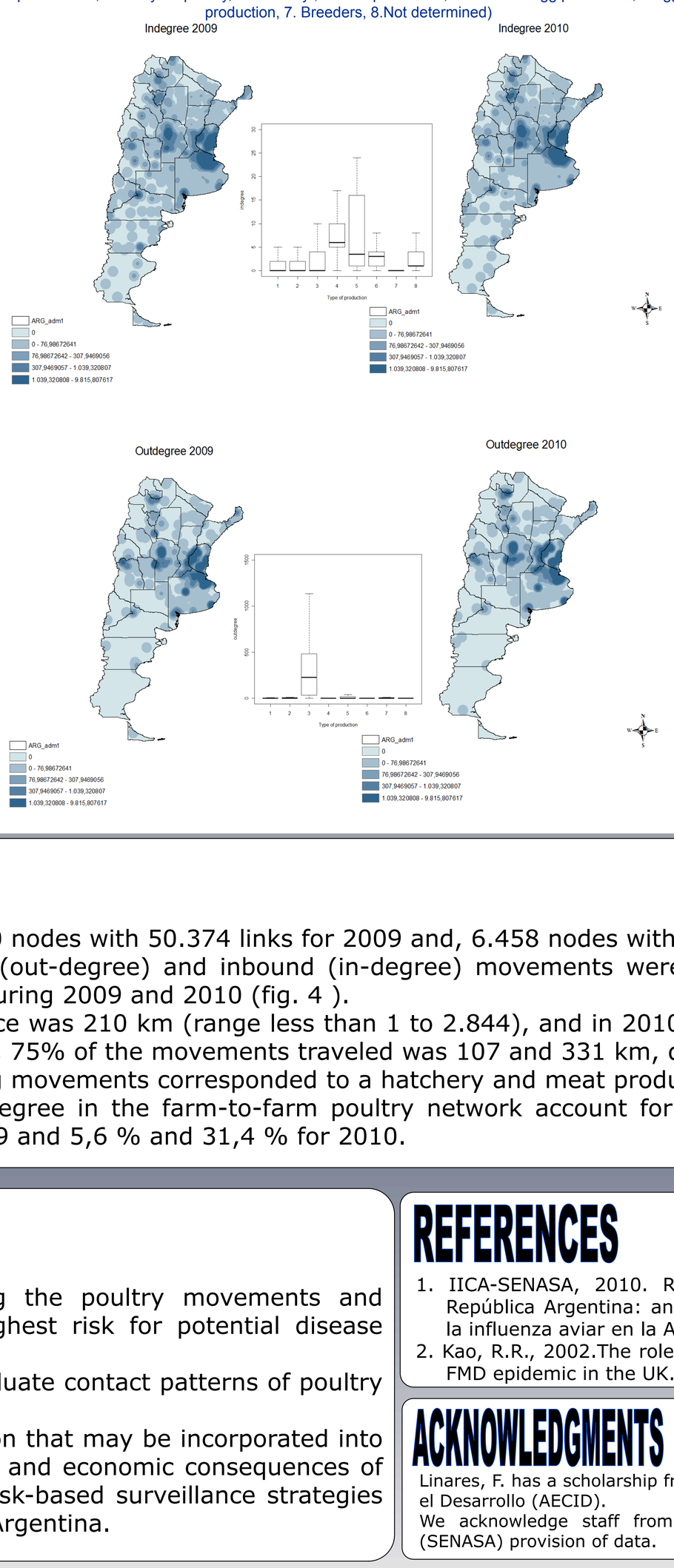
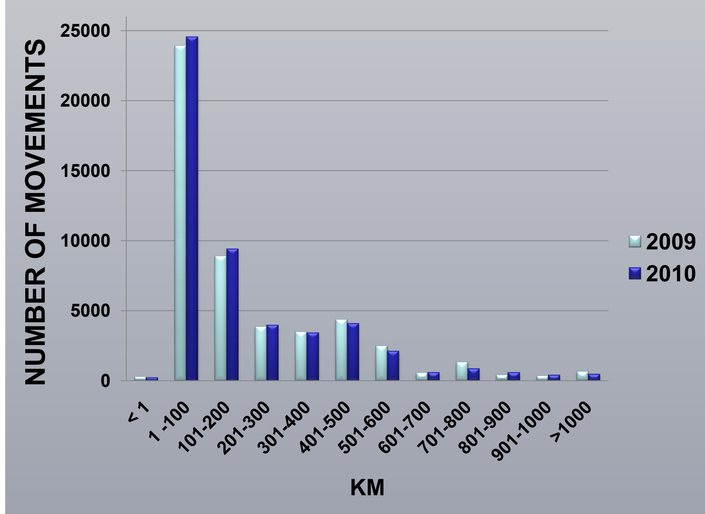


Figure 5. Frequency histogram, distribution of the number of movements (km), live birds to poultry farms to poultry farms in Argentina 2009 and 2010



RESULTS

The poultry contact network was compounded by 6.330 nodes with 50.374 links for 2009 and, 6.458 nodes with 50.566 links for 2010 (Fig. 2,3).
The provinces with the highest number of outbound (out-degree) and inbound (in-degree) movements were Entre Ríos and Buenos Aires, these two provinces account for 70 percent of total movements during 2009 and 2010 (fig. 4).
In 2009 the average of farm to farm movement distance was 210 km (range less than 1 to 2.844), and in 2010 the average was 198 km (range less than 1 to 2.577). During 2009 the distance covered by 50%, 75% of the movements traveled was 107 and 331 km, during 2010 was 104 and 292 Km (Fig. 5).
Nodes with the highest number of outgoing and ingoing movements corresponded to a hatchery and meat production farm respectively (Fig. 4)
The ten vertices with the highest input and output degree in the farm-to-farm poultry network account for 7,6 % and 31 % of the total number of incoming and outgoing shipments, respectively for 2009 and 5,6 % and 31,4 % for 2010.

CONCLUSION

This is one of the very first studies characterizing the poultry movements and identifying poultry farms, periods and regions at highest risk for potential disease introduction and/or spread.
Network analysis allows to better characterize and evaluate contact patterns of poultry farms in Argentina.
The study presented here provides essential information that may be incorporated into disease spread simulation models to quantify sanitary and economic consequences of potential epidemic in the country or used to design risk-based surveillance strategies and contingency plans of diseases affecting poultry in Argentina.

REFERENCES

1. IICA-SENASA, 2010. Riesgo de introducción de la influenza aviar en la República Argentina: análisis preliminar. Proyecto de Prevención y Control de la influenza aviar en la Argentina Senasa-IICA-Prosap (BIRF 7425-AR).
2. Kao, R.R., 2002.The role of mathematical modelling in the control of the 2001 FMD epidemic in the UK. Trends Microbiol. 10, 279–286.

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