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<th>Title</th>
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</thead>
<tbody>
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Geographical Information System (GIS) Technology Applied to a Spatial /Time Study of Tuberculous Restricted Reactor Herds in a Sample Area in Co. Carlow

R.F. Hammond and G. McGrath

Introduction
Since its establishment in 1989, the Tuberculosis Investigation Unit has been collecting and collating bovine tuberculosis data at national and farm level for application within a Geographical Information System (GIS). This paper describes a mapping procedure for the occurrence of bovine tuberculosis at farm level used to illustrate the time space relationship between restricted herds over a period of a calendar year. GIS studies of this type require detailed baseline mapping data. The Department of Agriculture, Food and Forestry made available, the 1994 sample data for an area in County Carlow covering a single sheet of the six-inch series (1:10,560). To maintain confidentiality no references are made to the specific sheet and associated herd numbers.

To examine bovine tuberculosis at farm level data were drawn down from the ERAD data set for all the herds within the study area. Herd history data were available for the years, 1988 - 1994; visible lesion data for all herds were not available for 1988.

The epidemiology of tuberculosis in cattle takes into account the time and place of the risk of exposure by cattle to the disease organism from e.g., animal to animal exposure, residual disease, wildlife and anergic animals (O'Reilly and Daborn, 1995). These factors and other management elements are appraised when veterinary inspectors complete the Epidemiology Report Form (ER76) for restricted herds (O'Keeffe, 1995).

Methodology
The digitised data from area aid application maps, in DXF format, were converted to an ARCINFO coverage. Attribute farm data were assigned to the respective farms. Within the boundary limits of the example sheet, a number of farms did not apply for area aid and farm and field outlines were therefore not digitised. The un-mapped farms were determined from the land registry map obtained from the Land Registry Office. These missing boundaries were digitised to complete the coverage. Enterprise types for the mapped farms were extracted from the database established by Fallon (1995). The verification of the farm and allocated herd number allows interrogation of the individual herd testing histories for all farms from the data base established from the ERAD records for the years 1981 - 1994. The data from these records are stored on the VAX computer and can be accessed using specially written software. Data were extracted for the number of reactors and total animals.
Information regarding the occurrence of "visible-lesion herds" (1989 - 1994) on farms was obtained from the tuberculin test records held on computer tapes by ERAD. Where possible earlier lesion histories were obtained for reactor herds, using hardcopy files held in the District Veterinary Office in Carlow. From these data, time and space maps were produced to show the monthly distribution of those herds in which tuberculin reactors had been disclosed through the years, 1981 to 1994.

The historical, within herd, testing data set drawn down for the herds present in the study area were modified to take into account reactors disclosed at private and inconclusive re-tests. The private test tends to be used specifically for animals for sale and generally applies to store or finishing animals.

The following conventions were established to allow consistency in handling the data: (1) Reactors disclosed at a private test were included in the next herd test. (2) Reactor(s) disclosed at an inconclusive re-test were allocated retrospectively to the previous herd test at which the inconclusive animal(s) was initially declared. (3) In order to establish the total number of animals in the herd for any one year test details were examined for that year and the maximum number of animals was taken at the round test.

The dates of movement restriction for all herds were entered into Microsoft Excel™ v5.0 and re-arranged so that, for each herd number there was a single row entry for all the herd restriction dates by the test type. The data were then joined to the data table for the coverage of farms in ArcInfo™ format. The restricted farm variables (number of reactors) in the farm coverage were re-selected using Arcview™ v2.1. Their spatial distribution for the year on year time series graphic display was exported to Microsoft PowerPoint™.

**Discussion**

Graphic output for a calendar year is illustrated in the figure on page 42. The restricted herds mapped, in solid colours, are categorised according to the number of reactors disclosed at the index test. The eradication scheme requires that, before a herd can be declared "free of tuberculosis", it must undergo two reactor re-tests, the first of which is carried out at a minimum of sixty days and the second test at a minimum of 42 days after the first.

Figure 1 shows that, in January, a herd disclosed five plus reactors; subsequently in February, two more herds in the vicinity disclosed reactors. In March, a further herd was restricted, disclosing a single reactor, in the mid-west of the area. Subsequently, the continuing restriction is shown by the lighter shade of the initial solid colour for the farms in the data set.

The application of the Bovine Tuberculosis Eradication Scheme's protocols shows that restrictions were in place for these herds through April/May, with the restricted herd of January disclosing a further reactor in April. A further herd to the south was restricted in May. A herd to the north disclosed five-plus reactors in June and, at the first reactor re-test disclosed a further reactor. This latter herd still remained restricted at the end of the calendar year with a further five-plus reactors being disclosed in December. A new restriction of a herd in October, with two reactors disclosed, yielded a
further reactor on the first reactor re-test.

This sequence of figures represents a sample of year-on-year data in this area, for 1981 - 1994, of space/time distribution patterns and illustrates the analytical capability of this approach in explaining some of the elements associated with the pattern of spread of bovine tuberculosis. These figures, and other data sets that can be applied but are not illustrated include the enterprise types, land use, soil type distribution patterns and drainage networks.

This accumulation of data and the associated protocols/methodologies in the GIS environment will have potential benefits in analysing the type of data that will be coming on stream from ER 76 forms submitted for disease outbreaks, e.g. animal to animal exposure in relation to ‘in farm’ and ‘between farm’ animal contact.

References

O’Keeffe, J. (1995). Preliminary Analysis of Reports Carried out on Selected Herds Using the ER 76 Investigation Format, In Tuberculosis Investigation Unit, University College Dublin, Selected Papers, 26 - 28


Legend

No. of Reactors Restrictions

- **Yellow**: 1
- **Blue**: 2
- **Red**: 3
- **Orange**: 4+

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