ASSESSMENT OF THE GEOGRAPHICAL RISK OF BOVINE SPONGIFORM ENCEPHALOPATHY – A PROPOSAL

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International trade in infected cattle and contaminated feedstuffs has spread the BSE-epidemic beyond its country of origin, Great Britain, creating concern for how to safeguard human and animal health while maintaining exports. If animals or animal products were excluded from export from a certain country because of locally detected BSE cases, then countries with inadequate BSE surveillance would be favoured. Instead it would be better to use the probability that cattle could be infected (pre-clinically or clinically) with the BSE-agent, at a given point in time (the Geographical BSE-risk = GBR) in a given country. Therefore, the Scientific Steering Committee that advises the European Commission has developed a method to assess this. The method is a qualitative risk assessment which uses information on 8 factors similar to those listed by the International Office of Epizootics (OIE): 1) cattle population dynamics, 2) animal trade, 3) animal feed, 4) meat and bone meal (MBM) bans, 5) specified bovine offal and specified risk material (SRM) bans, 6) surveillance, 7) rendering and feed preparation, and 8) BSE related culling. The GBR depends on the risk that the agent has been introduced to a country (external challenge), and the ability of the cattle system to cope with BSE (stability) in terms of enhancing or decreasing the infectious load of the system. In fact, the present GBR is determined by the interaction of these two factors over the past two decades. In this paper, an example of an assessment of changes in instability and challenge of BSE in a fictive country is presented by use of a two-dimensional diagram. Scales for each dimension are suggested and discussed, and rules for qualitatively interpreting their interaction and estimating the GBR are proposed.

Assessment of challenge and instability

An assessment of the first dimension, challenge, addresses the questions: has the agent been introduced to the country (external challenge), and if it has, to what extent has a domestic prevalence of BSE developed (internal challenge). The latter depends

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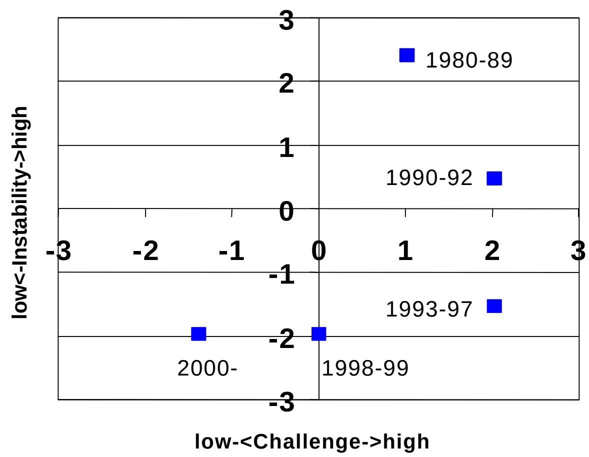
on the second dimension, instability: if the agent had been introduced would it have been amplified or reduced? A system's stability is determined by its ability to identify and eliminate BSE infected animals before they enter processing, and by its ability to avoid recycling BSE infectivity. To demonstrate the combined effect of challenge and instability a two-dimensional diagram may be used (Figure1).

Figure 1: Development in GBR in a country over two decades



In the example shown in Fig.1, an evaluation revealed that the country had been challenged throughout the 1980s while its system was very unstable. Hence it was located in the upper right corner of the diagram. The challenge gradually increased due to the unstable system. Due to implementation of risk mitigating procedures the system became more stable, which was reflected by a movement downward and, as no further external challenge occurred, eventually to the left. The final position on the challenge axis reflects the present GBR, and the final position on the instability axis, together with the present level of external challenge, reflects the rate and direction in which the GBR is developing.

Scales for the two dimensions

Numerical scales may be used for both dimensions to ensure the consistency of assessment over countries. Thus, a semi-quantitative assessment will support the qualitative assessment at points where this is possible. Since the evaluation of challenge and instability is mainly qualitative, it is important not to pretend a degree of accuracy that does not exist. Therefore, we suggest scales with levels from –3 to 3 covering the majority of observations. Using a numerical scale to describe challenge combines two ideas: the probability that BSE is present where it has not been reported, and the estimated prevalence where it has. We suggest $\log_{10}$ of the probability that BSE is present for the former situation, and $\log_{10}$ of the estimated clinical prevalence (per million) for the latter. The two arms of the scale meet at the lowest detectable prevalence, which might be assumed to be 1 per million, coinciding with a probability equal to one that BSE is present and represented by zero on our logarithmic scale. Hence, this value may be used for a country where BSE has not been found, but where it is highly probable that it is present. The value –3 represents an estimated probability that BSE is present of 1/1000, and +3 represents a prevalence of 1000 cases per million cattle. Note that in Great Britain at the height of the epidemic perhaps 1%, or 10,000 per million cattle, could have been infected, which would correspond to +4 on this scale. A suitable scale for describing instability would be based on the basic reproduction ratio (R_0) of the agent. R_0 may be defined as the average number of secondary infections that would be produced if one infected individual were introduced to a susceptible population. When $R_0>1$ the system is unstable, since the infectious agent has the potential to multiply. For Great Britain R_0 has been estimated to have been in the range 10-14 before the introduction of the MBM ban in 1988, close to 1 after its implementation, and approximately 0.15 after implementation of other risk mitigating strategies including the SRM ban. Applying a $\log_2$ transformation to R_0 changes the commonly observed range of values to –3 to 3, where 0 denotes neutral instability, i.e. $R_0=1$.

Interaction between challenge and instability

Instability is independent of challenge *per se* and reflects only what would happen if the agent were introduced to the system. However, if an external challenge is introduced to an unstable system the resulting internal challenge increases. The more unstable the system is the faster the internal challenge will increase. Additional external challenges will fuel this process. If no stability enhancing strategies are implemented the internal challenge will continue to increase, and this will be demonstrated on the two-dimensional diagram as a movement towards the right. After the implementation of strategies that render the system stable, challenge will begin to decrease. The more stable a system has become the faster challenge will decrease, and eventually it will be eliminated from the system. Any change in the observed incidence of BSE will be delayed due to the time lag between exposure and clinical disease (incubation period mostly about 4-6 years). In a system which is neutrally stable (instability-value: 0) the level of challenge will remain unchanged. The described interaction between challenge and instability may be depicted in the two-dimensional diagram as arrows of increasing length, where an arrow to the left describes declining challenge, and an arrow to the right describes increasing challenge.

The end result is an analysis of the full dynamic system, simplified into a scheme where the influences of instability and challenge have their own typical time processes. The past and current GBR and its trend are assessed. Hence this procedure is invaluable for an assessment of the BSE risk in a country or region.