INTRODUCTION

*Mycobacterium avium* subsp. *paratuberculosis* (MAP) have caused infections in European ruminants for more than a century, and some herds experience significant economical losses due to reduced milk production, reduced weight at slaughter, premature culling, loss of genetic potential and increased death rates. However, infections may pass unnoticed for several years in individuals as well as in herds. Because of these variable effects, and because other infections may cause greater losses or may have greater concern from a public health view, control of MAP infections does not always have a high priority. Furthermore, the prevalence of MAP infections may in some areas be low and the impact has therefore yet to be noticed, whereas the prevalence in other countries is high and considered to be a significant burden.

Several countries have implemented measures to approach MAP infections (Kennedy and Benedictus, 2001; Kennedy and Nielsen, 2006). These measures include control, surveillance and certification. Although some schemes are widely known, a number of other initiatives take place without having been described in widely available literature. This paper summarises approaches to MAP infections and go over the main points of efforts used to manage MAP in Europe.

TERMINOLOGY: AIMS IN MANAGEMENT OF MAP INFECTIONS

There are basically three main types of aims in management of infectious agents: i) control; ii) eradication; or iii) do nothing. Control can be defined as “any effort directed toward reducing the frequency of existing disease to levels biologically and/or economically justifiable or otherwise of little consequence” (Martin et al., 1987). Eradication can be defined as “the purposeful reduction of specific disease prevalence to the point of continued absence of transmission within a specified area by means of a time-limited campaign” (Yekutiel, 1980). Notice that real eradication is removal of MAP globally, whereas it is here used to also define regional removal of the agent. Basically, the word “eradication” is derived from the Latin word “radix”, meaning “root”, and “eradication” is the removal of the “root of the disease” i.e. for paratuberculosis it is MAP. Reasons to choose eradication over control are discussed by Payne (1963) and Yekutiel (1980).

The term “elimination” is by some used to describe the elimination of disease, but not pathogen (Payne, 1963). “Limem” means threshold and “elimination” is therefore a reduction to the limit/threshold where the root (pathogen) is present, but there is no disease. “Elimination” is by others considered to be “destruction of an infectious disease and its causal organism from a region of the world” (Anon., 2009a). “Doing nothing” is considered all other approaches not leading to control or eradication.

Differences in terminology emphasise the need to be specific in the description of different efforts. Furthermore, the above-mentioned differences suggest that distinction between “disease” and “root of disease” is important. The target condition may differ from one area or decision maker to another. Specification of the target condition is therefore important, especially for chronic infections, where there can be huge differences between being infected and being diseased.

EFFECTS OF MAP INFECTIONS

MAP infections usually develop over several years, and the incubation period may range from longer than the productive life-time to less than 2 years, in naturally infected animals. Furthermore, the effect of infection in the individual animal may vary significantly. This variation may be due to differences in management practices, e.g. intensive or extensive management, feed constitution, housing density etc. although these aspects are still poorly
described. The effects on animal and herd level are also different, because we are dealing with an infection, i.e. animals may become infectious. This means that an animal can be directly affected (e.g. reduced milk yield, weight loss, diarrhoea, death), or she can be indirectly affected through lost value at trading, simply because she is infected and carry MAP, and, hence, at risk of becoming MAP-affected in the future. On the herd-level, she can be a burden because she can transmit MAP to susceptible herd mates and thereby become a long-term liability to the herd-level productivity.

TARGET CONDITIONS
Different stages of infection (target conditions) are of interest from different perspectives considering the different effects at different time-points in the pathogenesis. Examples of different target conditions are: a) non-infected; b) MAP-infected; c) MAP-infectious; and d) MAP-affected. The latter is by some referred to as "clinical paratuberculosis", but this may be an unfortunate term, because "clinical" is often perceived as "observed" and the degree of observation usually differs greatly among observers. For example, in small herds, animals are often more closely observed whereas in large herds, individuals may not be observed directly on a regular basis. The target condition or case definition can therefore vary among decision makers and countries, but a clear definition of the target would be preferred to ease communication.

COLLECTION OF INFORMATION
A questionnaire was circulated to European members of the International Association for Paratuberculosis or veterinary authorities in the following European countries: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Switzerland, Slovakia, Slovenia, Spain and Sweden, requesting the recipient to respond to the questionnaire or forward it to persons involved in programme management. The questionnaire was designed to collect information on: A) Existence of a national or a significant regional approach on paratuberculosis, and the species covered by the programme; B) Reasons for establishment of the programme if one exists, or reasons for lack of a programme; C) Objectives of the programme; D) Organisations/institutions driving, managing and funding the programme; E) Strategies used to reach the objectives; and F) Supplementary information.

Based on the information collected, the countries were divided into four categories: I) non-responders; II) countries with a national approach or regional approaches for the whole country; III) countries with some regional approaches; and IV) countries without a national or a significant regional approach. Furthermore, the countries were divided into categories based on the objectives specified and the target condition of "paratuberculosis". Limited information was given for most countries.

PROGRAMMES ON PARATUBERCULOSIS
A map illustrating significant activities on MAP infections are shown in Fig. 1. Many responders provided limited information about the programme and it’s extent, and the map may not be very accurate and should be interpreted with care.

PROGRAMME OBJECTIVES AND TARGET CONDITIONS
The specified objectives of the different programmes are summarised in Table 1. There is considerable overlap between several objectives, e.g. reducing the prevalence of infected animals should reduce the spread of MAP and eliminate MAP shedders. However, the objectives given in the table were kept as close to the original specifications as possible. The information is categorised graphically in Fig. 2 illustrating the diversity of programmes in the European countries based on the information available.
Fig. 1. European countries specifying to have national or regional approaches (green), or with some regional control activities (yellow-grey). Some countries did not specify any significant activities (red), whereas others did not provide information (grey) or were not included in survey (black).

Table 1. Objectives and potential future aspects for control of MAP infections in European countries specifying to have programmes on MAP. The objectives are categorised as “passive” (red), “active control measures” (yellow) and “active eradication measures” (green)§

<table>
<thead>
<tr>
<th>Objective</th>
<th>Austria</th>
<th>Belgium</th>
<th>Croatia</th>
<th>Czech Republic</th>
<th>Denmark</th>
<th>Estonia</th>
<th>France</th>
<th>Germany</th>
<th>Greece (Lodi and Milano)</th>
<th>Italy (Veneto)</th>
<th>Luxembourg</th>
<th>Netherlands</th>
<th>Spain</th>
<th>Sweden</th>
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<tbody>
<tr>
<td>Report disease</td>
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<td>Provide financial support to affected farmers</td>
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<td>Identify herds with MAP</td>
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<td>Monitor prevalence of “clinical paratuberculosis”</td>
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<tr>
<td>Monitor herds for MAP (high) shedders</td>
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<tr>
<td>Monitor/establish prevalence</td>
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<td>Standardise control measures</td>
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<td>Prevent clinical losses</td>
<td>X</td>
<td>X</td>
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<td>Increase farmers' awareness and stimulate control</td>
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<tr>
<td>Eliminate MAP (high) shedders from dairy herds</td>
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<td>Remove sero-positive animals</td>
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<tr>
<td>Reduce spread of MAP</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Reduce economical losses</td>
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<tr>
<td>Reduce prevalence of MAP infected animals</td>
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<tr>
<td>Certification of animals with high genetic merit</td>
<td>X</td>
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<td>Secure trade with neighbouring countries</td>
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<tr>
<td>Document freedom of MAP disease</td>
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<td>Take precautionary measures on food safety</td>
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</tbody>
</table>

§“Eradication” in this context means removal of MAP from an area. Some of the objectives may fit into several categories.
ADDITIONAL INFORMATION ON SPECIFIC PROGRAMMES

Information on different programmes is often available in the language(s) of the specific country only (see list of additional country specific information in the back). Some of this information plus information provided in the questionnaires is briefly summarised here.

Austria
“Clinical Paratuberculosis” became notifiable in Austria in 2006, and the program is focused on animals with clinical disease. The government covers cost for laboratory examinations and provide compensation for culling of clinically affected animals. Management measures to reduce transmission of MAP are also implemented on farms with MAP affected animals.

Belgium
A voluntary programme on paratuberculosis in dairy cattle was established in Belgium in 2006, aiming at including 10% of producers in 2006 and 30% of producers by 2009. These goals have not been met. The programme is run by the dairy industry, farmers' organisations and animal health services.

In programme herds, all animals > 30 months of age are tested annually using antibody tests on milk or blood samples. Testing is paid by farmers, but he receives a bonus per animal tested as follows: 2 EUR per test-negative animal, and 3 EUR per test-positive animal that is slaughtered.

Denmark
Denmark also has a voluntary programme in dairy cattle. Approximately 29% of the herds and 40% of the cows were enrolled in the programme by June 2009. The programme is run as a risk-based control programme (Nielsen, 2009). All enrolled herds are tested 4 times per year using an antibody test, and cows are classified into High- and Low-Risk cows, and specific measures should be established to reduce potential MAP transmission from High-Risk cows. All costs are paid by the farmers.

France
Different programmes exist in different regions of France, but they are all voluntary. On a national level, a programme exists to certify animals with a high genetic potential. On a regional level, different control schemes are in place, for example in the main dairy region in France, Bretagne, where around 20,000 cattle farms and 2 million cattle are considered “active in paratuberculosis control”. Control activities include different test-schemes, where test-positive animals are culled within a specific time interval, and measures to reduce MAP transmission to calves are implemented.

Germany
Paratuberculosis is notifiable in Germany. However, there is no obligation to test animals with clinical signs of this disease. Owners and veterinarians often refrain from submitting samples to diagnostic laboratories in order not to know if an animal or herd is paratuberculosis positive. The reason is that farms reporting cases may be held responsible for the damage caused by knowingly selling animals from paratuberculosis positive herds to another farm, whereas those that do not know their status are not, irrespective that the prevalence can be similar in the reporting and the non-reporting herd. The Federal Ministry for Consumer Protection, Food and Agriculture in 2005 made guidelines to standardise control measures, to reduce the prevalence of clinical disease and thereby economic losses, and to prevent spread of MAP. The implementation of the guidelines lies with the individual German states. Financial support can be obtained through infectious disease insurance programmes in some states if specific requirements are fulfilled.

The Netherlands
A bulk milk quality assurance programme was established in the Netherlands in 2006, and by 2008 approximately 75% of the herds had voluntarily joined the programme. The aim of the programme was to reduce the concentration of MAP delivered to milk factories. All herds are tested at minimum every 2nd year with a highly specific but insensitive antibody ELISA. Tested herds are classified in three categories: A) Herds with only test-negative animals; B) Herds with test-positive animals, where all test-positive animals are removed from the herd; and C) Herds with test-positive animals remaining in the herd. The Dutch dairy industry has made participation compulsory for farmers delivering milk to their factories from 2010. Only herds in category A and B can deliver milk from January 1, 2011.

Spain
There is no national approach to MAP infections in Spain, but in the Basque Country, there are initiatives to reduce the prevalence and reduce losses associated with the infections in cattle. Two main tools are used in two different regions: vaccination in the Gipuzkoa region, and test-and-culling using serological and faecal test schemes. Furthermore, the use of vaccination may be extended to other regions within the next 5 years. Several other initiatives are in place in other parts of the country, but with less specific programme objectives.

Sweden
Sweden claims that the prevalence of MAP infections is low. They aim at providing test-information to ascertain freedom of MAP infections, but struggle with providing test-information that can certify herds and animals free of MAP.

Fig. 2. Objectives and approaches to MAP in different European countries

REASONS FOR NOT HAVING A PROGRAMME
Reasons for not having a programme are specified in Table 2. The primary reasons seem to be that MAP infections have lower priority than other infectious diseases, economical constraints and perceived low prevalence. A few countries are considering introducing programmes.

DISCUSSION
Compiling information on programmes dealing with infectious diseases in Europe is a challenge. The terminology appears to differ significantly, and the lack of a clear definition of “paratuberculosis” and differences in target conditions further confuse the interpretation of the information collected. However, the information collected suggests that a variety of initiatives exist, although there is limited information on the actual participation in these initiatives. Successful initiatives have still to be effectively documented. Lack of such documentation may be the reason that so many different initiatives exist. Furthermore, MAP infections are of low priority in several countries, and the lack of documented successful initiatives may also be an explanation for that. Such documentation will be pivotal for future standardisation of approaches leading to control or eradication of MAP.

Table 2. Reasons for lack of programme on MAP in European countries specifying not have a programme

<table>
<thead>
<tr>
<th>Country</th>
<th>Reasons for lack of programme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cyprus</td>
<td>Apparent high prevalence of herds with MAP infected animals, but cattle are not reported affected by MAP infections. Sheep and goats are reported affected by MAP infections, but losses are considered limited. Vaccination is used if problems are experienced. MAP infections are not of high priority because problems are considered limited.</td>
</tr>
<tr>
<td>Finland</td>
<td>Not considered a problem based on some pilot projects. Only 5 beef herds and no dairy herds were identified with MAP in 1992-2008. At the present, surveillance is based on clinical signs and the veterinarians have to report further, if paratuberculosis is detected at a farm”. Poor diagnostics are a discouragement in the establishment of a programme.</td>
</tr>
<tr>
<td>Hungary</td>
<td>MAP infections are not of priority.</td>
</tr>
<tr>
<td>Ireland</td>
<td>MAP infections were not considered a problem until after introduction of “The Single Market” in the European Community (European Union) in 1992. MAP infections were not really recognised until about 2000. A programme may be established in the future.</td>
</tr>
<tr>
<td>Lithuania</td>
<td>No specific programme on MAP, but a general infectious disease programme is in place for breeding herds. Breeding establishments should do regular MAP testing. The prevalence is considered low, but a survey may be carried out in near future to establish the prevalence.</td>
</tr>
<tr>
<td>Poland</td>
<td>Economical constraints and a general belief that there is no disease in the country.</td>
</tr>
<tr>
<td>Portugal</td>
<td>A prevalence study suggested that although many herds /flocks of ruminants (cattle, sheep and goats) were infected, the animal level prevalence was so low that priority should be given to other infections, primarily Brucella melitensis.</td>
</tr>
<tr>
<td>Slovakia</td>
<td>Economical constraints.</td>
</tr>
<tr>
<td>Slovenia</td>
<td>Prevalence is considered so low that MAP infections are not considered a problem by cattle breeders and the government.</td>
</tr>
<tr>
<td>Switzerland</td>
<td>Diagnosis is too complicated.    Exact implications in human disease are not known. Resources currently bound to BVD eradication and bluetongue virus control. A future programme is a possible target.</td>
</tr>
</tbody>
</table>

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