Chapter 6

Effectiveness

ToR 5.

Examine the extent to which the programme's objectives have been achieved, and comment on the effectiveness with which they have been achieved.

6.1 Introduction

The Programme Logic Model introduced in Chapter 4 shows that the Programme's effects can be differentiated – by reference to the time frame over which they manifest themselves and the societal groupings they benefit – into *results* and *impacts*. Evaluation of effectiveness at the *results* level requires an examination of the programme's success in transforming its outputs into beneficial effects for the targeted beneficiaries in the short to medium term. Evaluation of programme *impact*, on the other hand, requires that the focus be broadened to include not just the targeted beneficiaries, but society as a whole, and extended to encompass the medium to long-term.

The long-term objective of the Programme has already been stated [Chapter 2] as being

> The eradication of bovine tuberculosis.

And the interim objective has been stated as being that of

> Controlling bovine tuberculosis at levels consistent with maintaining trade in bovine animals and their products, at minimum cost to the Exchequer, while overcoming the barriers to eventual eradication through investment in research and technology.

The interim and long-term objectives are interlinked, in that the 'control' and 'technological development' components of the interim objective create the conditions for the eventual achievement of the long-term objective. Specifically, this chapter will examine whether the BTEP, over the period under examination, has:

- achieved its objectives; and
- achieved the objectives in a cost-effective manner.

The first question will be addressed exclusively in this chapter, while the second will be discussed hereunder and in Chapter 8. This chapter will focus on how cost-effectiveness might be improved by altering the mix of resources already available within the

Programme as currently configured. Chapter 8, on the other hand, will look at how cost-effectiveness might be improved by the adoption of novel policy or organisational approaches. The *impact* of the BTEP and its continued *relevance* are discussed in Section 6.8 and 6.9, respectively.

6.2 Compensation

6.2.1 Direct compensation

An effective compensation system will be transparent and equitable and will ensure that a fair (market) price is paid for all categories of reactor animal, thereby encouraging herdowner co-operation, discouraging fraud and contributing to two of the Programme's intermediate outcomes – the resolution and the containment of infection. In setting appropriate rates of compensation for TB reactors, the Department is guided by these basic principles as well as by the legal framework – including the Constitution and EU legislation – within which the Programme operates. EU State Aid guidelines[1] establish that compensation payments will be determined on the basis of the market value of animals killed, but that they will not exceed such market value. Entitlement to compensation in respect of reactors is not automatic, however, but contingent on compliance with certain legal obligations attaching to the keepers of animals.

It is clear that a programme for the eradication of bovine tuberculosis that failed to recognise herdowners' expectations to redress *via* a compensation mechanism would be unlikely to elicit sufficient support from the farming community to be viable and could be subject to legal challenge. Reactor compensation can therefore be reasonably regarded as being a necessary 'overhead' of any programme, and it has formed an integral part of the BTEP since the programme's inception in the 1950s.

<u>Cost-effectiveness of the direct compensatory mechanisms</u>

Under the RGS, which was fully phased out in April 2002, farmers received from the Department a 'flat-rate' payment as determined by a pre-established 'table' valuation system in addition to the amount paid by the meat factory in respect of the animal's salvage value. A previous examination of the adequacy of compensation concluded that, within the period 1977-1989, the ratio of compensation paid to the estimated annual depreciation fluctuated widely above and below 1.0, indicating that the system both over- and under-compensated for reactors at different points in time. Because different categories of reactors received compensation at different rates, certain classes of animals attracted excessive compensation even while aggregate compensation failed to keep pace with aggregate reactor depreciation. The reverse was also true. For the whole period 1977-1989, the ratio of compensation to reactor depreciation was 0.86, indicating 'significant underpayment' to farmers (Sheehy and Christiansen).

Since the introduction of the OFMVS, compensatory payments made to farmers represent the difference between the actual valuation placed on the live reactor animal and the salvage value. The discrepancy between the market value of an equivalent healthy animal and the salvage value of the reactor is referred to as the Gross Differential Amount (GDA) and it will be greater or lesser depending on the suitability of the reactor animal for slaughter and on the extent of competition between meat factories for reactor cattle [5.10]. In contrast to compensation rates under RGS, which were only infrequently reviewed, compensation under OFMVS is determined by reference to robust and representative market price information, collated on a weekly basis from a variety of sources and subject to a comprehensive quality control system [5.6.3]. It is to be expected, therefore, that compensation amounts awarded under the present system should more closely reflect market values than was the case under the RGS.

6.2.2 Indirect compensation

Depopulation Grant

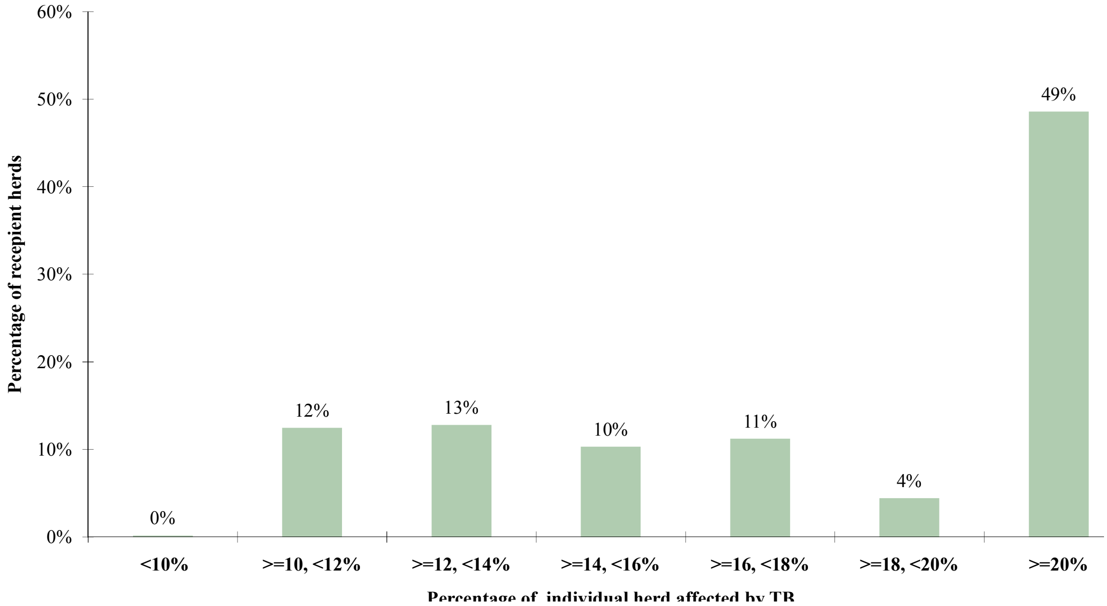
The decreasing recourse to full-herd depopulation has been described in Chapter 4 [4.2.2]. The advent of a blood-based diagnostic test (IFN-γ), which, in conjunction with the intradermal test, provides the technological capacity to optimise the removal of diseased animals from infected herds, reinforced a move away from whole herd depopulations that was already apparent. This shift in policy is attributable to the experience, accumulated over many years, that depopulation is not always an effective means of reducing the risk of repeat breakdown. This is an unsurprising finding given that some 75% of breakdowns can be attributed to an infected local wildlife source [6.4.1], which will continue to constitute a source of repeat infection whether or not the affected herd is depopulated.

Income Supplement

Income Supplement is designed to compensate for loss in income arising from the removal of cattle as reactors. However, it does not follow that the loss of cattle due to tuberculosis necessarily results in income loss for the herdowner and it is certainly the case that the extent of any such income loss will vary according to the category of reactor and the time of year at which the reactor is removed. The most obvious loss arises in the case of dairy cows and the consequential loss of income from the sale of milk from the cows removed as reactors. In the case of non-dairy cattle, losses may arise from the early sale of immature cattle or the loss of potential 'added-value'. However, the extent of the losses incurred is greater during the grass-growing season, when feed costs are low and productivity is at its highest, than it is during the winter months when feed costs are relatively high and productivity is low. This was particularly evident in 2007 when there was a very substantial increase in both feed costs and the price of milk. As stated in Chapter 5, the rate of grant is uniform throughout the year and, apart from a higher rate for suckler cows, is not differentiated according to the various categories of cattle. It is evident that the effectiveness of this measure could be enhanced by ensuring that the rates payable for the various categories of reactor animals are differentiated so that they better reflect the actual losses incurred.

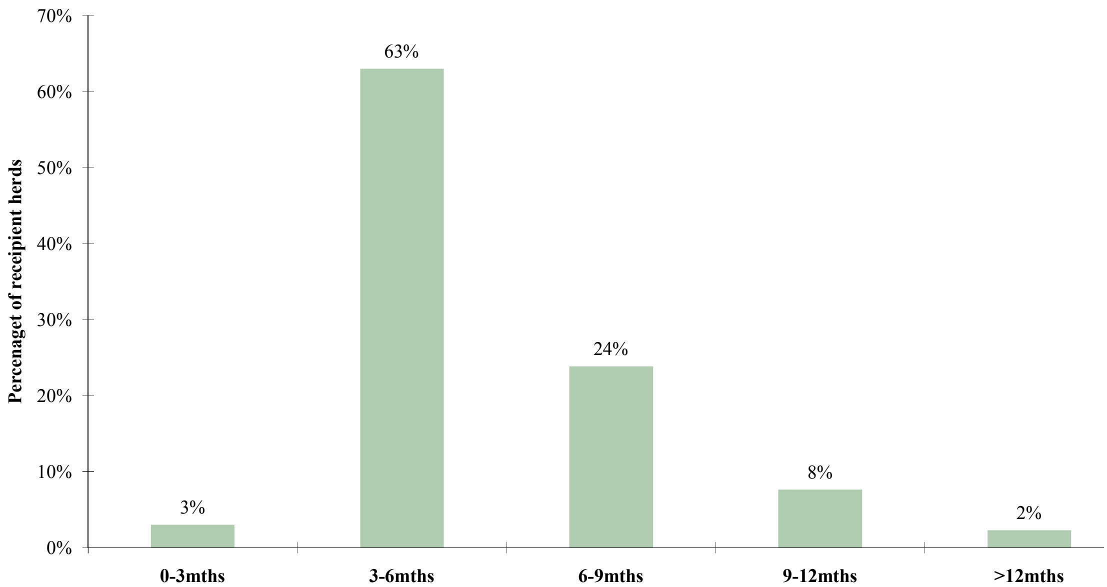
The effectiveness of the measure is also a function of the extent to which recipients are correctly targeted. An analysis of 562 recipients of Income Supplement payments in 2006, carried out for this review, examined how these payments were distributed by reference to the proportion of the individual herds affected by tuberculosis and the period of time for which payments were received. Figure 6.1 shows that in approximately 50% of recipient herds, less than 20% of the herd had been removed over the course of the tuberculosis restriction. These herds accounted for 32% of expenditure in the sample.

Figure 6.1 Income Supplement recipient herds (threshold analysis)



Source: DAFF

Figure 6.2 Income Supplement recipient herds (period analysis)



Source: DAFF

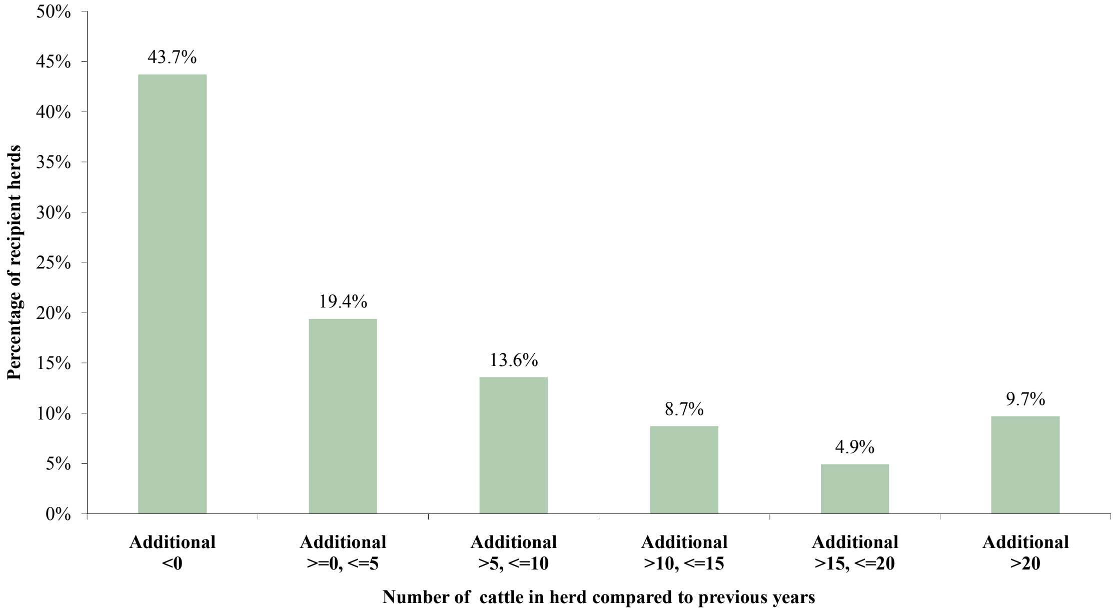
In relation to the period over which payments were made, Figure 6.2 shows that just 34% of the herds sampled were in receipt of Income Supplement payments for periods of more than 6 months, with 2% receiving payments for more than 12 months. The former group accounted for 67% of all expenditure in the sample. The period of eligibility is an important variable in determining the effectiveness of the Scheme because the herd profile on a farm may change and may revert, in some cases, to normal levels during the period the herd is under restriction. Alternatively, changes in the nature of the enterprise undertaken, in particular, a shift towards finishing cattle for slaughter, may lessen the impact of the restriction on an individual farm. In the interests of improving the targeting of the payment, it would thus seem appropriate for the Department to adopt a policy of reviewing herdowners' continuing eligibility after they have been in receipt of Income Supplement for 6 months.

Hardship Grant

The rates of grant under the Hardship Grant Scheme are relatively undifferentiated. Currently, the scheme provides for just two rates of grant: €38 per month for suckler cows and €25 per month for other cattle. Preliminary work undertaken in the context of this review indicates that the cost of feeding cattle over the winter months varies significantly depending on the age or category of animal and, moreover, that the cost of overwintering is often offset by an increase in value in the case of certain categories of cattle. These *cost of feed/increase in value* differentials are not adequately reflected in the current flat rate grant system. In addition, it would seem that animals such as cows that are part of the stable, intransient herd should not normally be considered eligible for the Hardship Grant as farmers will generally have made provision for the overwintering of this category of animal, irrespective of the disease status of their herd. These provisional findings indicate the need to carry out further work aimed specifically at establishing the appropriateness of the rates of grant payable under this Scheme.

In relation to the targeting of the grant, analysis of a random sample of recipients, carried out for this review, showed that not all had additional cattle in their herds at the beginning of the qualifying period of the year (1st November – 30th April), compared to their stocking levels at comparable periods in previous years [Figure 6.3]. While many of these herdowners would go on to have higher than usual cattle numbers on their holdings later in the year because of the restrictions on the sale of cattle from their herds, the finding is of interest, given that the objective of the scheme is to assist farmers facing *additional* feed requirements as a result of the restriction. Better targeting of the measure could be achieved if it were to be confined to those herdowners who can demonstrate that they have additional cattle and feed requirements in their herds as a result of restrictions imposed for bovine TB control purposes.

Figure 6.3 Hardship Grant recipient herds (stocking levels analysis)



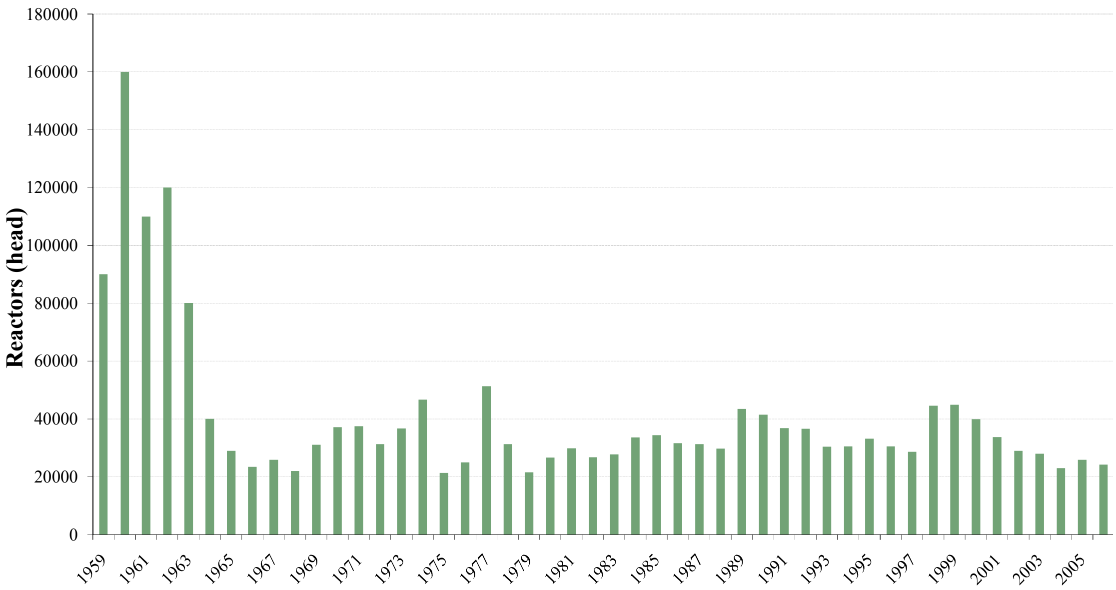
Source: DAFF

6.3 Disease surveillance and control

Measuring the effectiveness of any eradication or control strategy against an infectious disease such as bovine TB is complex, requiring, as it does, an evaluation of disease dynamics at the animal level as well as between and within herds. Clearly, no one measure can provide sufficient information to be considered to be a comprehensive evaluative tool. Consequently, it is usual for herd-based and animal-based indices to be used in parallel in an effort to provide a more complete perspective of the disease situation. The principal measures currently used by the Department include Herd Incidence (the number of newly restricted herds as a percentage of the population of clear herds tested within a defined period), APT (number of reactor animals per 1,000 animals tested within a defined time period) and the number of reactor animals in a given period. Animal-based indices are important from the perspective of understanding the 'pool' of potential infection that exists within the national population and as a means of estimating the costs associated with compensation measures, which are a function of individual reactor animals. Herd-based indices are significant in that they provide a measure of the effectiveness of strategies aimed at limiting spread into new herds.

6.3.1 Disease trends

Figure 6.4 Annual reactor numbers (1959-2006)



Source: DAFF

As is apparent from Figure 6.4, dramatic progress was made in reducing disease levels, as measured by reactor numbers, in the period from the Programme's inception in the 1950s until the point at which Ireland declared itself free of the disease (attested) in 1965. The other principal measures of disease discussed above – herd incidence and APT – are not shown as they were not consistently available in the early years of the programme.

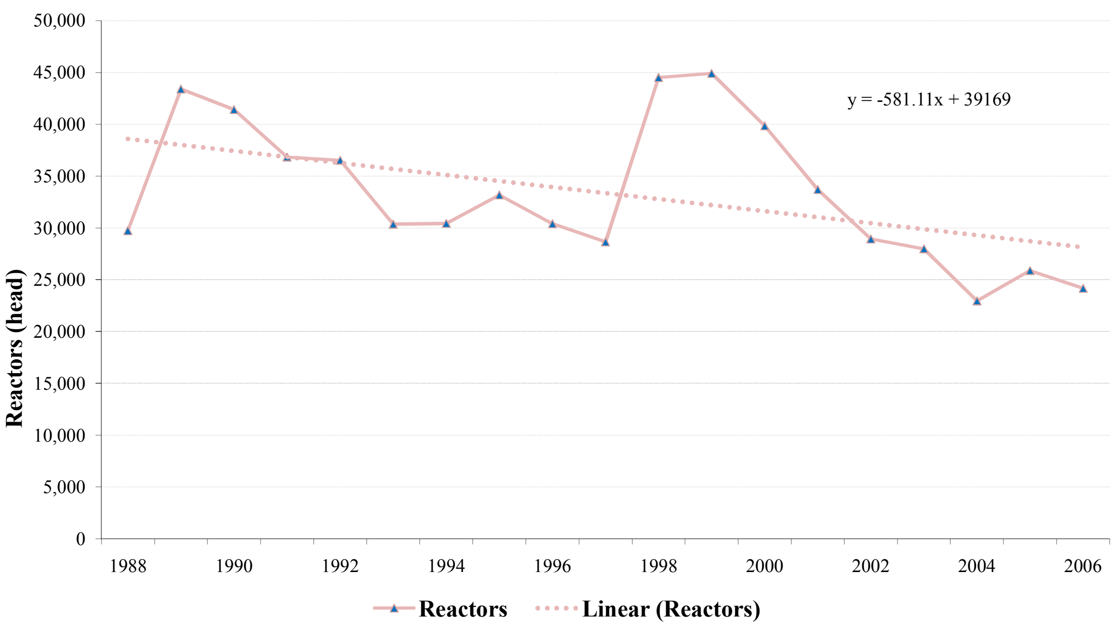
From 1965 to the present, reactor numbers have oscillated within a range of approximately 20,000 to 45,000 per annum. Over this time, the figure of 40,000 reactors has been breached on 6 occasions: in 1974 and 1977; in 1989 and 1990; and in 1998 and 1999. The increased rate of reactor extraction in the 1970s is attributable to interruptions to the tuberculin testing programme resulting from funding shortages and to an industrial dispute by veterinary practitioners, which resulted in the curtailment of TB testing in 1976.

1988-2006

The choice of time period for the following analysis is not fortuitous. Programme funding has effectively been guaranteed only from the ERAD period (1988-1991) onwards, and comparisons of disease trends over time thus have a greater validity if limited to this period than is the case if data from preceding periods, in which funding was frequently subject to retrenchment, are included. Furthermore, because data in respect of APT and herd incidence were unavailable before this time, it is not possible to provide a more complete perspective of disease trends for earlier periods.

While the peaks in reactor extraction in 1989 and 1990 can be directly attributed to the intensification of programme measures that took place during the three-year period of ERAD management, those recorded a decade later, in 1998 and 1999, have no such clear-cut explanation. Although it is known that bovine TB follows a cyclical pattern in cattle, the pronounced increases observed in these years cannot be explained simply on the basis of the underlying cyclicity of the disease. However, despite the adverse performance in 1998/99, the trend for the full period under discussion was for reactor numbers to decline by just under 600 *per annum* from the 1988 level, as is evident from the trendline in Figure 6.5.

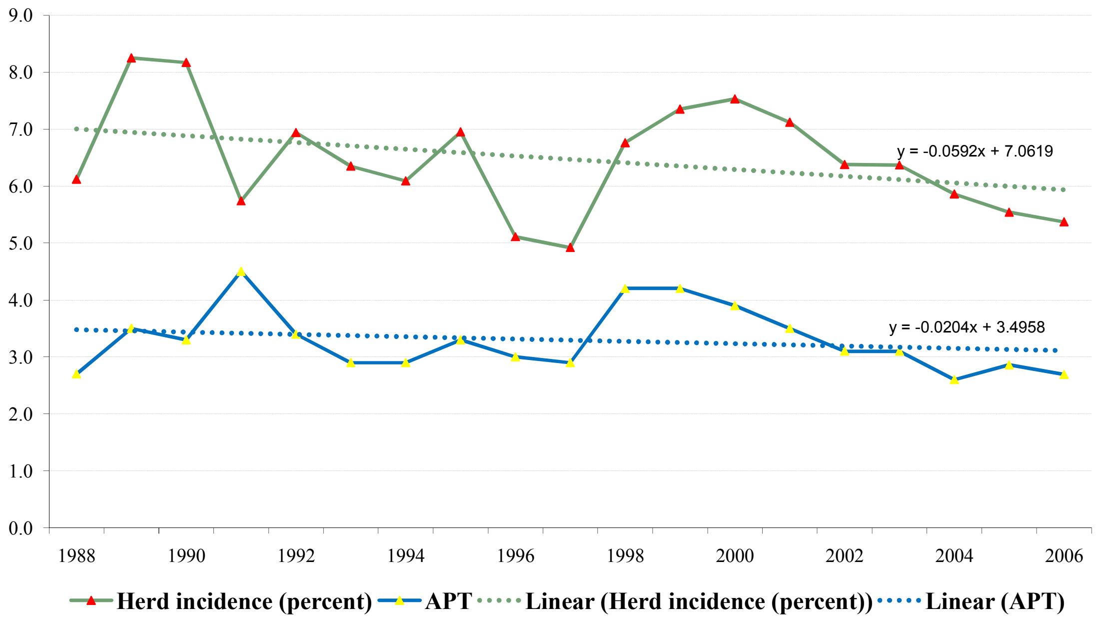
Figure 6.5 Annual reactor numbers and linear trendline (1988-2006)



Source: DAFF

The pattern for herd incidence and APT is similar to that for reactor numbers. In 2006, APT stood at 2.69, which was the second-lowest value recorded over the period under review (2.60 in 2004), while the herd incidence was 5.37%, the lowest value recorded since 1997 [Figure 6.6]. Disease levels as measured by the principal indicators – reactor numbers, APT and herd incidence – have all been below the respective long-term trends since 2004. This improved performance in the latter half of the period under analysis may be partially attributable to the underlying cyclicity of bovine tuberculosis but may also reflect the enhancement of a number of key programme measures over this same period. These include improvements in: quality control procedures; reactor and incontact tracing; regulation of cattle dealers; targeting of tuberculin testing; alternative diagnostic techniques; and wildlife intervention. The impact of the Wildlife Unit, which was created in 2002, and which has adopted a targeted approach to wildlife interventions [4.4], is likely to have been particularly significant, although poorly quantifiable, given that it is just one of a range of improvements to have come into effect around this time. The beneficial effect of these programme enhancements notwithstanding, however, it is unlikely that a significant and sustained improvement in the disease situation can be achieved until such time as a comprehensive solution to the wildlife-cattle infection cycle has been developed [4.5.2, 6.4.5].

Figure 6.6 Herd incidence, APT and linear trendlines (1988-2006)



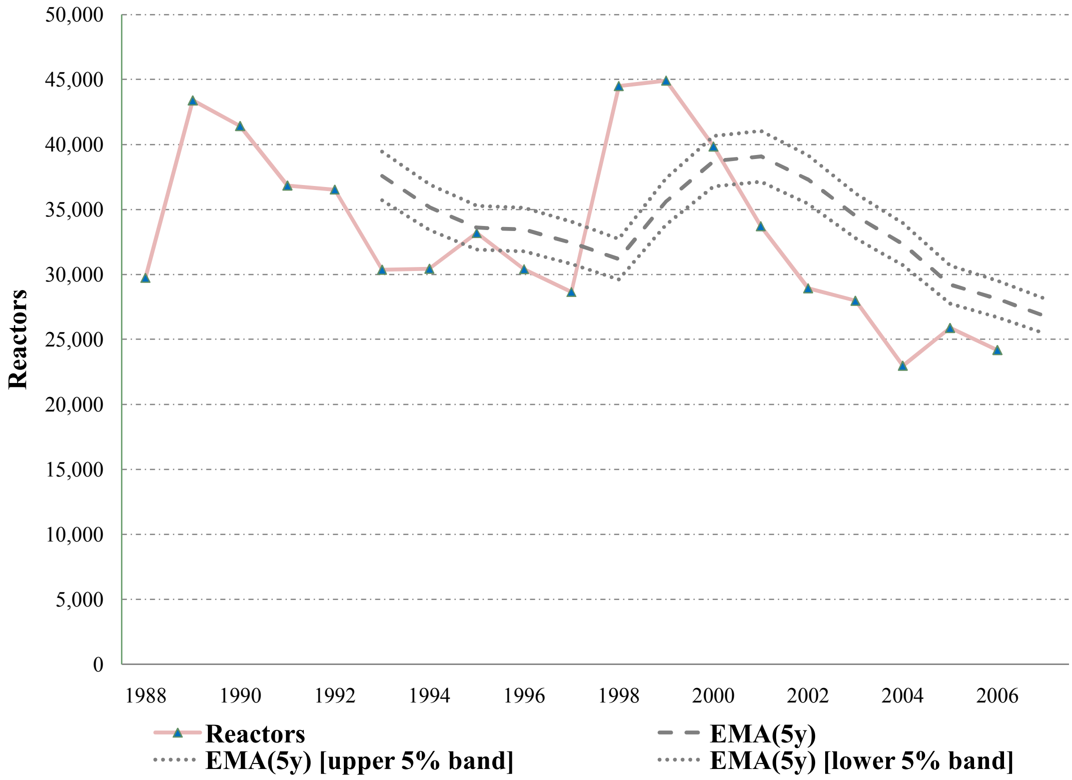
Source: DAFF

6.3.2 Measuring performance against Programme objectives

It is of interest, in light of discussions in Chapter 2 [2.4.1] on the quantification of the interim objective, to compare actual performance across the three principal disease indicators against the exponential moving averages of these indicators, as proposed in that chapter. The following three figures display actual disease data against a five-year exponential moving average (EMA) and against a 'band' equivalent to 95% and 105% of the EMA. It is apparent from these figures that actual disease outcomes in the years 1998 and 1999 departed markedly from the long-term trend, before resuming a downward path from 2000 onwards. By 2001, reactor numbers and APT were both less than 95% of the EMA, while herd incidence stood at just below 105% of the moving average. From 2004 to the end of the period under review, all three parameters remained below 95% of the EMA.

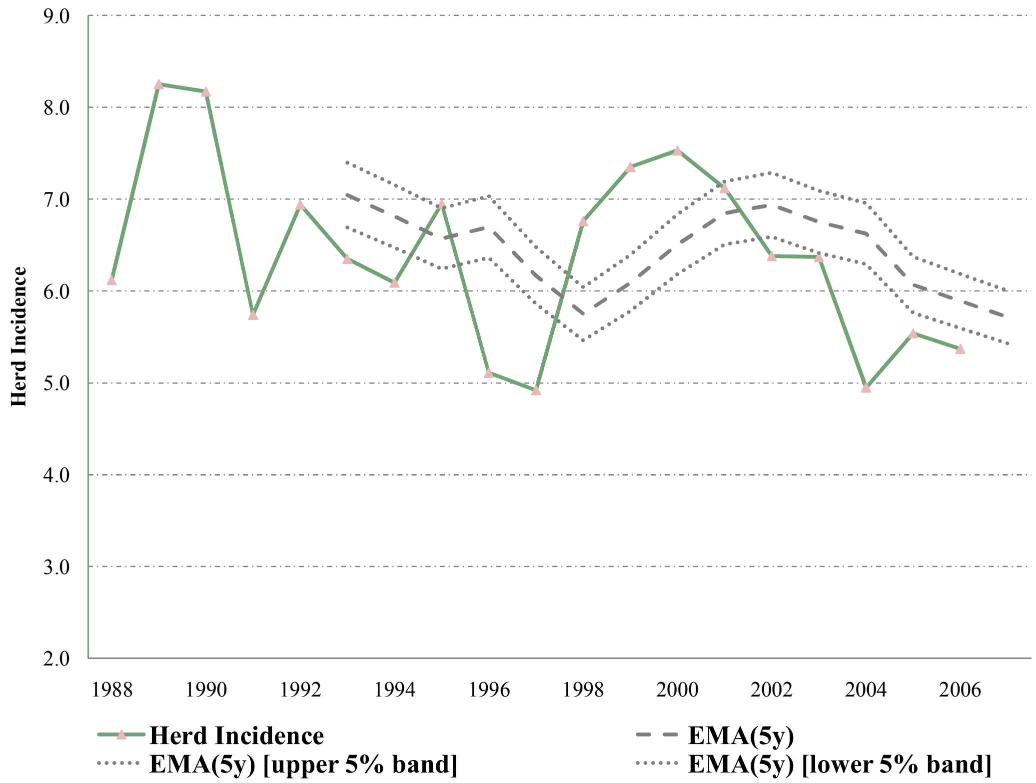
Comparing disease outcomes against a moving average of the outcomes of a number of previous years is preferable to comparing current year outcomes with those of the preceding year alone. Moving averages 'smooth out' underlying disease cycles and dilute statistical anomalies that may arise when disease data are reported on an annual basis. The moving average can be more or less sensitive to recent events, depending on the time window chosen and on whether the average chosen is simple or exponential in nature. The moving average recommended in Chapter 2 and displayed graphically below is relatively sensitive to recent performance, given the relatively narrow 5-year 'time window' and the choice of an exponential, rather than a simple, average. Sensitivity can also be varied depending on the choice of the 'band' running either side of the moving average. The 5% tolerance band displayed in the accompanying graphics has been chosen with a view to signalling adverse performance only in those situations in which it is warranted.

Figure 6.7 Reactors and 5-year Exponential Moving Average (1988-2006)



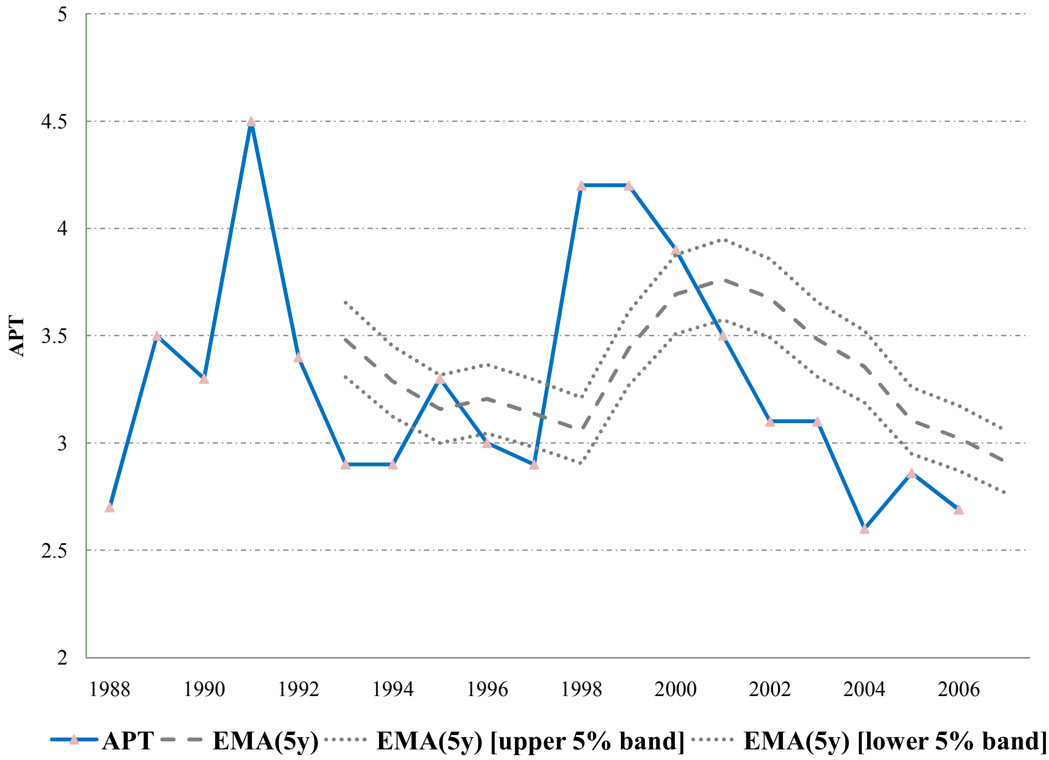
Source: DAFF

Figure 6.8 Herd incidence and 5-year Exponential Moving Average (1988-2006)



Source: DAFF

Figure 6.9 APT and 5-year Exponential Moving Average (1988-2006)

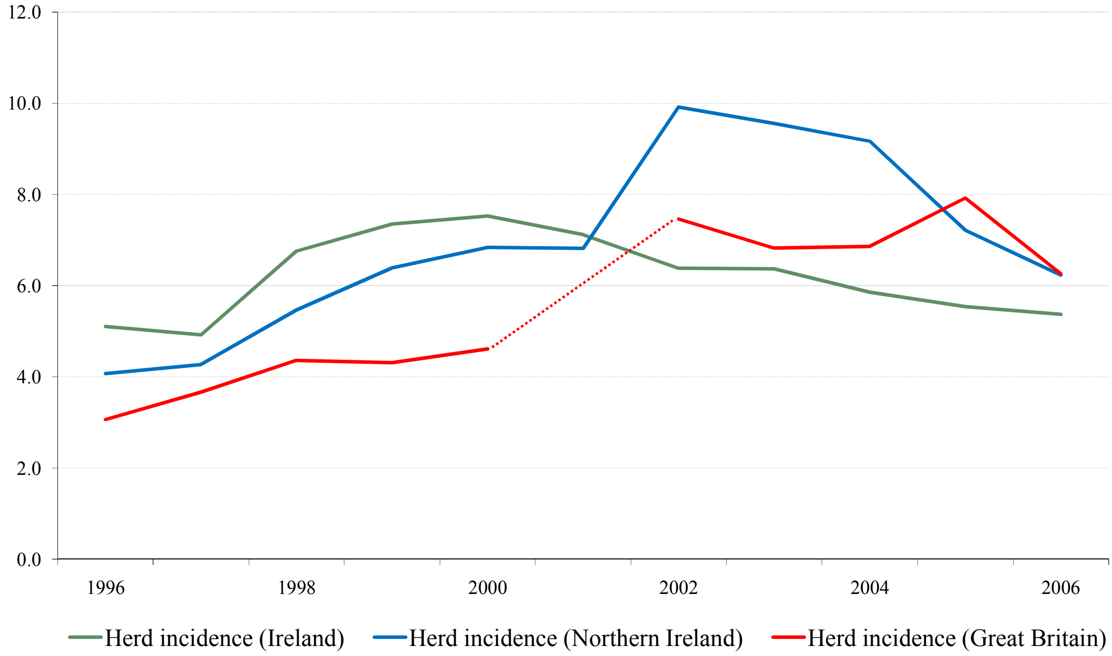


Source: DAFF

6.3.3 International comparisons

It is difficult to directly compare the incidence of TB in Ireland with that in Northern Ireland and Great Britain because of differences between the respective jurisdictions in the manner in which statistics are compiled. For example, in Northern Ireland, disease episodes first detected by means of post-mortem inspection are not included in TB statistics unless the follow-up herd test discloses further cases in the herd of origin. Cases detected by post-mortem inspection are, by contrast, included in the reporting of disease in Ireland, irrespective of the outcome of the subsequent herd test. In 2006, 37% of all disease episodes in this jurisdiction were first detected by means of post-mortem surveillance; of these, some 80%, on average, will fail to disclose further reactors during the course of that episode (Olea Popelka et al., 2008). Further differences also arise between Ireland, on the one hand, and both Northern Ireland and Great Britain, on the other, in relation to the classification and treatment of disease episodes.

Figure 6.10 International comparisons of APT and Herd Incidence (1996-2006)



Source: DAFF, DARD, Defra

Note: The TB testing programme in Great Britain was severely disrupted in 2001 due to FMD

The above caveats notwithstanding, disease data for the period 1996-2006 in respect of the three jurisdictions are displayed graphically in Figure 6.10. Herd incidence in Northern Ireland in 1997 stood at ca. 4.1% but rose to peak levels of 9.9% in 2002, when herd testing was suspended as a result of Foot and Mouth Disease (FMD). In 2006, herd incidence stood at 6.23%, a decline of nearly 40% from 2002 levels. In Great Britain, herd incidence climbed from ca. 3.1% in 1996 to 4.6% in 2000, before rising significantly, to 7.46%, in 2002 following the lacuna caused by FMD in 2001. In Ireland, starting from a higher level of ca. 5.1%, herd incidence increased during the period 1997-2000, reaching a peak of 7.5% in 2000 before declining to levels of about 5.4% in 2006. While similar patterns are evident in relation to APT, comparisons of this rate across jurisdictions may be complicated by the intensity of the tuberculin testing programmes undertaken in the respective jurisdictions.

6.3.4 Cost-effectiveness of intradermal TB testing

Measures Required for Intra-Community Trade

As stated previously, Directive 64/432/EEC does not provide the basis for eventual eradication of the disease. The Directive merely sets out the standards that are required to allow for continued intra-Community trade in bovine animals. Nevertheless, the measures undertaken under the BTEP can be divided into two broad categories: (i) those measures (including the majority of TB tests) which would in any event, given Ireland's TB levels, fall to be implemented because of the requirements of the Directive; and (ii) those, such as the six month check test and the compensation measures, without which an eradication programme would simply not be effective.

Member states wishing to engage in intra-community trade are obliged to carry out an annual surveillance test on all herds unless the average herd incidence, as measured on two consecutive annual monitoring periods, is 1% or less. Further reductions in the frequency of surveillance testing are permitted upon reaching herd incidence thresholds of 0.2% and 0.1%, when such testing can be carried out on a triennial and quadrennial basis, respectively. Given that the herd incidence in 2006 stood at 5.37%, it is reasonable to suggest that Ireland will not be in a position to reduce the frequency of the present national surveillance testing programme for many years.

A full herd test is carried out on almost all of the 119,000 herds in the country every year. In 2006, 56% of all testing was of the annual surveillance (round test) type. When herd tests of all types are taken into account, the percentage of the national herd tested each year over the period under review ranged between ca. 97% and ca. 98%, with the exception of 2001, when the testing programme was interrupted due to Foot and Mouth disease [Table 4.2]. Many of the small percentage of herds nominally untested in the course of a year are subsequently found to have ceased cattle farming, either temporarily or permanently, or are newly created herds.

In addition to the obligations imposed in relation to surveillance testing, the Directive also requires that tuberculosis-free status remains withdrawn from herds in which the disease has been confirmed until two consecutive herd tests have been carried out within specified time intervals. In the Irish Programme, Reactor Retests, and Factory Lesion Tests are timed to ensure that restoration of tuberculosis-free status will meet the Directive's trading rules. Furthermore, animals whose status is unresolved (inconclusive) are required to be isolated from the rest of the herd and to be either retested within a specified interval, or slaughtered. The Directive also obliges member states to carry out 'tracing and checking' on any herds considered to be ‘epidemiologically related’ to a herd in which tuberculosis has been confirmed. The Department carries out tracing of epidemiologically related herds and herds contiguous to infected ‘fragments’ of holdings with the aid of ICT systems such as *Herdfinder* and AHCS and these herds are checked by carrying out Special Check or Contiguous Tests. These tests may also be considered to fulfil the trade requirements of the Directive, given that an epidemiological relationship with the infected herd may arise from cattle-to-cattle contact across farm boundaries, or from a common environmental source, such as an infected badger. Finally, the Directive lays down that cattle being exported from one member state to another must *inter alia* have passed an intradermal tuberculin test to a specified standard within 30 days of loading. Much of the private testing carried on in Ireland is for the purpose of establishing eligibility for export. A full schedule of the test types used in the BTEP is provided in Appendix L.

Analysis of the tuberculin testing returns for 2006, presented in Figure 6.11, shows that approximately 85% of all animal tests were tests which are required to fulfil the terms of the trade Directive 64/432/EEC. Annual surveillance testing (type 1), accounting for 56% of all animal tests, is assumed here to be paid for by farmers in accordance with the terms of the revised testing arrangements introduced in 1996[2]. If private testing, accounting for 3% of animal tests, is included, the overall proportion of tests paid for by farmers comes to 59%. The remaining 26% of tests carried out in fulfilment of the terms of the Directive are principally for the purpose of disease control (containment and resolution) and to enable the restoration of herd OTF-status. These tests are paid for by the Department.

Testing not required by the Directive

Because certain of the tests not nominally required under the Directive will effectively substitute for others that are so required, and because tests in certain other categories (e.g. Contiguous Tests) will exceed the requirements of the Directive in terms of the frequency with which they are conducted, it is difficult to be precise in relation to the exact extent to which testing carried out under the BTEP exceeds EU legislative requirements as they relate to trade. On the basis of the analysis presented in Figure 6.11, the proportion of tuberculin testing carried out under the Programme that is not directly required by the Directive is approximately 15%. Figure 6.11 also shows that the cost-effectiveness of these tests, as represented by the expected reactor 'yield' (APT), is greater than that for surveillance testing carried out in compliance with 64/432/EC.

Figure 6.11 Classification of TB test types (2006)

PURPOSE		PURPOSE					
		64/432 Compliance			Other		
		Type	% Animal tests	APT	Type	% Animal tests	APT
PURPOSE	Surveillance	1	56.35%	1.30			
		2	0.28%	1.70	5(h)	0.01%	90.13
		3	0.04%	220.27			
		5(e)	0.18%	1.05			
		6	2.89%	0.60			
		10(b)	0.04%	25.57			
		5(a)	4.57%	2.52			
		S/Total	**64.35%**	**1.52**	**S/Total**	**0.01%**	**90.13**
	Control	**Type**	**% Animal tests**	**APT**	**Type**	**% Animal tests**	**APT**
		4	15.53%	5.50	5(c)(d)	3.69%	1.20
		9(a)	3.14%	10.59	7(a)(b)	6.37%	2.85
		5(b)(f)(g)	0.30%	18.09	8 [Note 2]	4.49%	3.59
		8 [Note 2]	1.93%	3.59			
		10(a)(c)(d)	0.20%	9.67			
		S/Total	**21.08%**	**6.22**	**S/Total**	**14.56%**	**2.66**
		Total	**85.43%**	**2.78**	**Total**	**14.57%**	**2.13**

Source: DAFF

Notes: 1) Red font indicates tests generally paid for by farmers

2) For the purpose of this analysis, Contiguous Tests have been apportioned between '64/432 Compliance' and 'Other' tests in the ratio 30:70

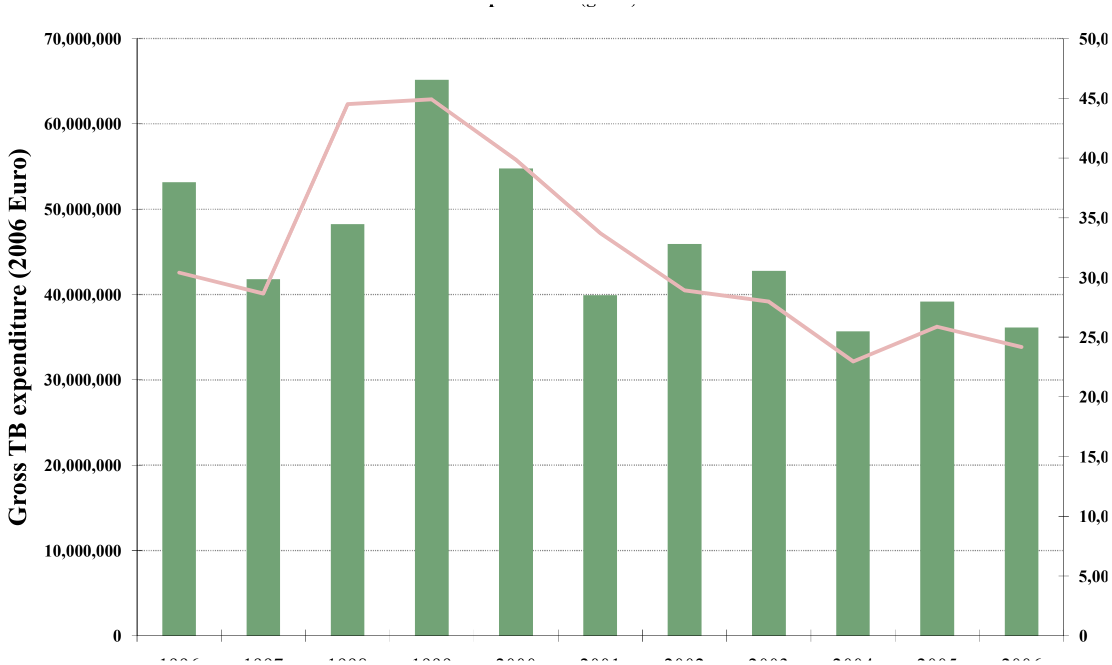
<u>Targeted approach to tuberculin testing</u>

For both categories of testing identified above, one of the principal methods of optimising the cost-effectiveness of tuberculin testing is to ensure that testing for the purpose of disease control is appropriately targeted. The Department, over time, has developed a programme of risk-based testing of infected herds, the effect of which is to concentrate testing in those areas in which infection has been confirmed. This approach has been assisted by the development of software [4.7.3] to enhance the targeting of herds subject to additional control testing. Separately, the Department has developed a 'Singleton Protocol' that minimises unnecessary additional testing in those herds in which a TB reactor has been identified, but where disease has not been confirmed. Eligibility for the protocol depends *inter alia* on the disclosure of no more than a single reactor at the index test, the nature of the reaction to skin test, the absence of disease in the index herd in the preceding three years, and the absence of high-risk contiguous herds. The disease status of herds entering this protocol is suspended, rather than withdrawn, and the herd is derestricted following the completion of a single clear herd test providing TB is not confirmed in the reactor at post-mortem or following laboratory analysis and that all other eligibility criteria continue to be met.

<u>Rate of reactor extraction</u>

One of the principal lessons learned following the completion of the ERAD mandate in the early 1990s was that increased expenditure and the rigorous application of the then available tools of eradication would not be sufficient to eradicate bovine tuberculosis in a context in which the continual 'seeding' of infection from wildlife reservoirs is the principal constraint to eradication. On the contrary, increased expenditure, unless accompanied by certain technological and socio-economic advances, would be ineffective and wasteful of state resources. At the heart of this argument is the concept that there exists a minimum threshold of disease – estimated then to be of the order of 25,000 reactors *per annum* – which is a consequence of the existence of an infected wildlife reservoir and certain inherent imperfections of the diagnostic test (Downey, 1991).

Figure 6.12 TB expenditure (gross) and TB reactors (1996-2006)



Source: DAFF

Over the full period under review, the annual rate of reactor removal ranged from 23,000 to 45,000 and the average (mean) rate of extraction was 32,000 reactors per annum. However, the average annual extraction rate in the most recent five-year period (2002-2006) was, at 26,000 reactors, 32% below the average for the preceding five years. Figure 6.12 shows the close relationship between reactor numbers and programme cost over the period under review.

6.3.5 Effectiveness of the Interferon-gamma (IFN-γ) assay

The Interferon-gamma (IFN-γ) assay is authorised for use as an adjunct to the intradermal test under both European and national legislation[3]. Although it is currently the only supplementary test that has such approval, research is ongoing into the development of further alternative diagnostic tests, such as the anamnestic ELISA test and other antibody-based tests. The Department has been actively involved in supporting a number of these research initiatives.

While the assay has been demonstrated to increase the effectiveness of reactor removal when used in conjunction with the SICTT in certain specific circumstances, its relatively lower specificity compared to the latter precludes its use as a routine screening test. In addition, the requirement within the Irish programme to maximise the sensitivity of the assay – which requires that the samples be set up for processing in the laboratory within 8 hours of collection – imposes certain logistical constraints on its more widespread application.

On the other hand, the assay is capable of detecting a subset of infected animals that does not respond to the skin test and it therefore has a role, in conjunction with the intradermal test, in optimising the removal of infection from certain herds. Further, because it does not require injecting the animal with tuberculin, it is not subject to the same limitations regarding the inter-test interval as are intradermal tests. In common with other blood-based tests, the assay possesses another important potential advantage, when compared with intradermal tests, in that it mitigates the 'moral hazard' [3.3.2] associated with the latter by shifting the point at which test interpretation takes place from the field to the laboratory, with consequent benefits for the perceived objectivity of the test. Finally, by reducing the emphasis on the field inspection component of quality control systems, the assay creates scope for improvements in both efficiency and cost-effectiveness.

Department policy on the use of IFN-γ

The primary target is the high-risk[4] breakdown episode, which at present accounts for approximately 30% of all breakdowns. Within such herds every effort is made, on the basis of an epidemiological investigation by a Department veterinarian, to confine the application of the test to those cohorts of animals most likely to have been exposed to infection. Because of limitations in the assay's specificity, it is generally only used on animals over a year old.

Chronically infected herds, of which there are some 3,000, are also targeted when they experience a breakdown within two years of a previous high-risk breakdown episode[5]. In these cases, the target is for all adult animals in the herd to be tested using the assay in order to reduce the risk of undetected residual infection or possible onward spread to other herds. The use of the assay is also recommended in certain inconclusive animals and in situations where doubts exist as to the true tuberculous status of any animal.

Beyond the relatively limited circumstances identified above, any improvements in the effectiveness with which TB is diagnosed cannot be expected until such time as existing or emerging diagnostic technologies achieve levels of accuracy similar to or higher than that of the intradermal test.

Cost-effectiveness

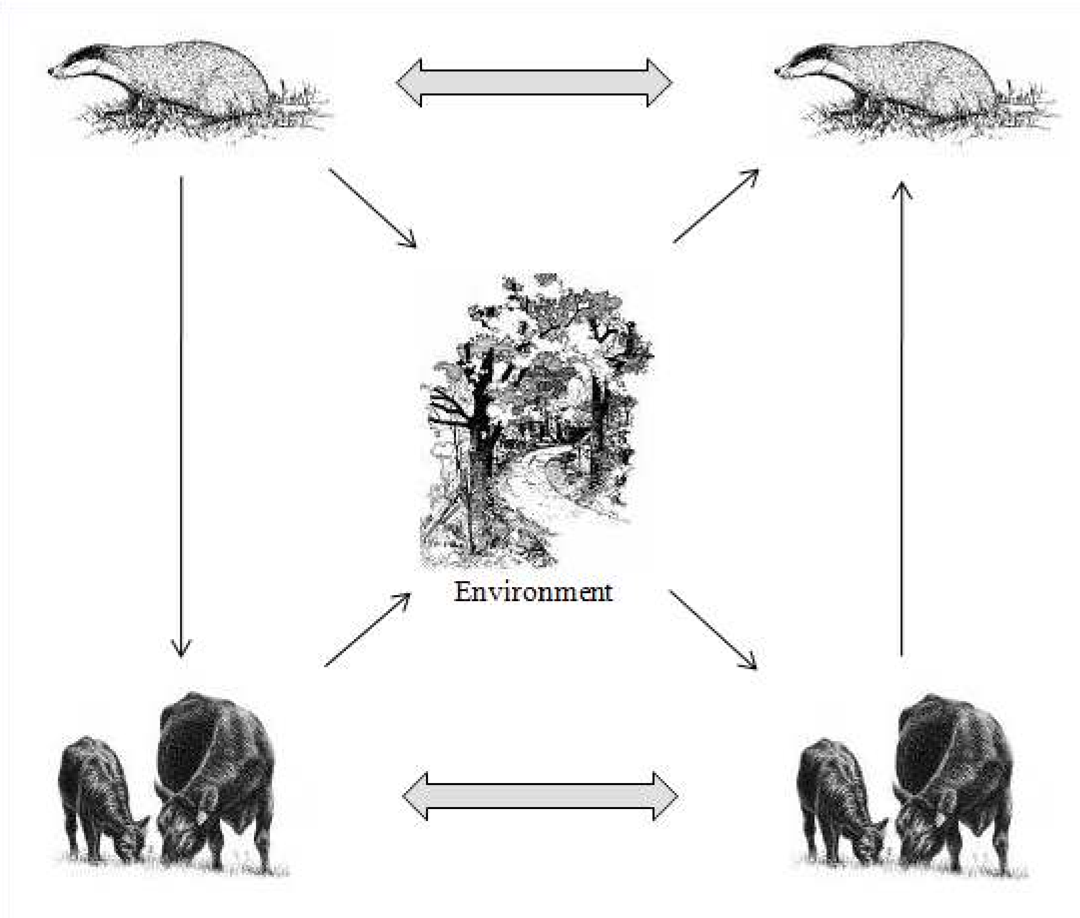
The cost of the IFN-γ assay was discussed in the previous chapter [5.7.5], where it was shown to be over six times more expensive per test than the intradermal test. Furthermore, the lower specificity of the assay relative to the SICTT results in the identification of greater numbers of non-infected reactors than would be the case using the latter test alone, thereby increasing the cost of reactor compensation. On the other hand, the deployment of IFN-γ is thought to facilitate the resolution of certain TB breakdowns more rapidly than would be the case using the SICTT alone and to have contributed to the decreasing use of costly herd depopulations as a means of resolving severe breakdowns [4.2.2]. The Department is currently undertaking a study that will seek to evaluate the effectiveness of IFN-γ, in conjunction with the SICTT, in shortening the restriction period in reactor herds in comparison to herds subject to intradermal testing alone. It is expected that the results of this study will assist the Department in optimising the cost-effective use of this resource.

6.4 Wildlife control measures

6.4.1 Evidence base for Department wildlife policy

The effectiveness of the Department's present policy on wildlife is underpinned by the body of research conducted in this country and elsewhere into the epidemiology of *M. bovis* in cattle and badgers and, in particular, the results of the East Offaly Badger Project and the Four Area Project [Appendix B]. The Four Area Project (FAP) was a major field trial, carried out between 1997 and 2002, which investigated the impact of badger removal on the control of tuberculosis in cattle herds in Ireland. Building on the previous East Offaly Badger Research Project, the FAP was designed around four paired 'removal' and 'reference' areas located in four different counties and it incorporated measures to address the possibility of inward migration of badgers into the removal area during the course of the project. The study concluded that there was a significant difference in the risk of disease occurrence between the removal and reference areas in all four counties. In the final year of the study, the odds of a confirmed herd restriction in the removal (as compared to the reference areas) were 0.25 in Cork, 0.04 in Donegal, 0.26 in Kilkenny and 0.43 in Monaghan. Further, over the full period of the study, the rate at which herds were becoming the subject of a confirmed restriction in the removal area was 60–96% lower than in the reference area. The conclusion drawn from these findings was that these effects could be reasonably attributed to the proactive removal of badgers. The authors acknowledged that widespread badger removal (although feasible) is not a viable or desirable strategy for the long-term control of tuberculosis in the Irish cattle population, affirming the need to build on existing research into the development of an effective vaccine for badgers (Griffin et al., 2005, 2005a) [4.5.2].

Figure 6.13 Cattle-to-cattle, badger-to-badger and badger-to-cattle disease cycles



Source: DAFF (for source of images see endnote[6])

Analysis of the source of herd breakdown recorded in the reference areas over the period of the Four Area Project indicates that 75% of these can be attributed to the presence of badgers. This emphasises not only the importance of the badger to the disease eradication programme but also the effectiveness of the national programme in limiting cattle-to-cattle transmission (More & Good). This analysis is closely corroborated by recent research in Great Britain, which attempted to quantify the proportion of transmission attributable to cattle movements as compared to that due to other causes (Green et al.). The British study concluded that, of the various models of disease transmission constructed, the best explanation of bovine TB breakdowns in 2004 was provided by a model attributing 16% of herd infections directly to cattle movements and a further 9% to unexplained causes. The best-fit model assumed low levels of cattle-to-cattle transmission and attributed the remaining 75% of infection to local effects within specific high-risk areas.

6.4.2 Legal status of the badger

The badger is a protected species under the terms of the Wildlife Act of 1976. Section 23 of this Act makes it an offence for any person to hunt a protected wild animal except in accordance with a licence granted by the Minister, to injure a protected wild animal except while (legally) hunting it, or to wilfully interfere with or destroy its breeding place. Additional protection is afforded under the terms of the Bern Convention on the Conservation of European Wildlife and Natural Habitats 1979, which classifies the badger as a 'Protected Fauna Species'[7]. The protected legal status of the badger under domestic and international legislation has significant consequences for the BTEP, strongly influencing both the strategic approach to eradication and the manner in which costs of the programme are distributed between public and private sectors [3.2.1].

6.4.3 Evidence from Great Britain

The effectiveness of badger culling as a means of reducing the incidence of disease in cattle has been the subject of considerable debate in Great Britain. Research carried out there has pointed to the possibility that badger culling as carried out in Great Britain may result in increased transmission of tuberculosis from badgers to cattle due to the 'perturbation' (disruption) of the social organisation of badgers (Donnelly et al.). More recently, the report of the Independent Scientific Group on Cattle TB (ISG) reached the similar conclusion that reactive culling leads to increased, rather than reduced, incidence of TB in cattle, and that proactive culling is ineffective because the reduction in bovine TB incidence in culled areas is offset by an increased incidence of bovine disease in surrounding un-culled areas (ISG, 2007) [Appendix B].

The ISG report accepts that badgers contribute significantly to the disease in cattle, and does not contest the effectiveness of proactive badger culling in reducing bovine disease incidence within the culled area. However, the policies arising from the Four Area Project in Ireland, on the one hand, and the Randomised Badger Culling Trial (RBCT) in the United Kingdom, on the other, diverge strongly, belying the extent of common ground in relation to the fundamental findings. This divergence is not surprising, given the existence of significant differences between the two studies in terms of their respective objectives and design, and given the disparate farming practices, environmental conditions, capture methods, and badger ecology in the respective jurisdictions.

The findings of the ISG report have not been uncontroversial within the United Kingdom. In July 2007, the British government's Chief Scientific Adviser commented on the ISG report with a view to assessing the scientific evidence presented therein and assisting the Department for Environment, Food and Rural Affairs (Defra) in reaching policy conclusions. The Chief Scientific Adviser found that the work carried out by ISG had demonstrated that culling over large areas and over a significant period of time produces beneficial effects on the incidence of bovine TB, and concluded that the removal of badgers on this basis

> ...could make a significant contribution to the control of cattle TB in those areas of England where there is a high and persistent incidence of TB in cattle, provided removal takes places alongside an effective programme of cattle controls.
>
> (Chief Scientific Adviser)

This conclusion is contested by the ISG, which argues that it 'underplays' the issue of perturbation and simultaneously misinterprets the findings of the RBCT with respect to culling over large geographic areas ($300km^2$). The ISG consequently stands behind its finding that badger culling does not result in a net economic benefit (House of Commons). Most recently, the Environment, Food and Rural Affairs Committee of the Parliament of the United Kingdom, assessing the evidence from both the ISG and Chief Scientific Adviser, concluded that, under certain well-defined circumstances, it is possible that culling could make a contribution towards the reduction in incidence of cattle TB in hot-spot areas. However, the Committee could only recommend the licensed culling of badgers under section 10 of the Protection of Badgers Act (1992) if such culling is carried out in accordance with those conditions agreed between the ISG and the Chief Scientific Adviser. These were that culling should: be done competently and efficiently; be coordinated; cover as large an area as possible ($265km^2$ or more is the minimum needed to be 95% confident of an overall beneficial effect); be sustained for at least four years; and be in areas which have 'hard' or 'soft' boundaries (House of Commons).

6.4.4 Development of wildlife policy options

Up until the conclusion of the Four Area Project, much of the research carried out in Ireland into the interaction between cattle and badgers in the transmission of bovine TB was aimed at determining the impact on disease levels in cattle of the removal of badgers from the local environment. The focus of research up to that point was thus the accumulation of *evidence* for the effectiveness or otherwise of interventions aimed at breaking the badger-cattle disease cycle. The evidence from the Four Area Project is consistent with that from the ISG report in Great Britain in respect of two key findings: (i) that badgers contribute significantly to bovine tuberculosis in cattle; and (ii) that proactive badger culling is effective in reducing bovine disease incidence within the culled area.

Having established that breaking the badger-cattle disease cycle is likely to be an effective means of significantly reducing TB levels in cattle, the focus of research has now moved on to examining the various policy *options* for achieving this objective. Considerations of cost-effectiveness (including trade implications) and of environmental and ethical sustainability quickly narrowed the long-term strategic approach to that of developing an effective vaccine for badgers. The resource implications of developing a nationwide programme of field vaccination of badgers are significant and it is not expected that the primary research phase of this project, including the analysis of results, will be completed until 2013 at the earliest [4.5.2].

6.4.5 Interim wildlife strategy

Current Department strategy in relation to the wildlife vector has been developed, in conjunction with the social partners, having regard to the accumulation of strong evidence (from the Four Area Project and other sources) of the crucial role of wildlife in constraining eradication, on the one hand, and the outcome of research into the development of a vaccine for badgers on the other. While the acquisition of the capability to implement a viable national programme of badger vaccination remains the key research priority for the BTEP, the development of an interim wildlife strategy is a necessary policy response in the intervening period. The creation, in 2002, of the Wildlife Unit [4.4] marked the beginning of a move away from the *ad hoc* approach adopted previously which, although it had resulted in the capture of significant numbers of badgers from the 1980s onwards, did not constitute an integrated, national response to the badger problem. The strategic approach subsequently adopted under Social Partnership and implemented by the Wildlife Unit is to concentrate resources on the control of infection in badgers in those areas of the country where tuberculosis in cattle herds is both persistent and chronic. Apart from their direct effect on bovine TB levels, the activities of the Wildlife Unit result in the generation of information of considerable value to the ongoing badger vaccine project.

County Monaghan was chosen to pilot the new approach from the late 1990s onwards as a result of the persistent high levels of bovine tuberculosis in the county at that time. As a consequence, Monaghan was the first county in which the percentage of land under treatment reached 30% (in the first half of 2006), in line with the targets set out at the time of the Wildlife Unit's establishment. Although the interim wildlife strategy is national policy, its deployment has been incremental and it has not yet been implemented with the same intensity in other counties as it has in Co. Monaghan. In December 2007, the average percentage of land under treatment across all counties was 18.5%.

Bovine disease data for Co. Monaghan, presented in Table 6.1, show that the number of episodes of tuberculosis fell by 69% between 2000 and 2006 and that the severity of disease has also lessened over time, the proportion of episodes with no standard reactor increasing from 25% to 51% of all disease episodes. Table 6.2 shows that, from 2000 onwards in particular, the herd incidence fell from 9.0% to stand at 3.8% in 2006. APT, which had oscillated between 6.40 and 10.20 in the period 1996-2000 declined steeply thereafter, falling below the national average in 2006 for the first time in the period for which data are provided. Given the existence of a three-year time lag between intervention on the badger population and observed effects on TB levels in the bovine population (More and Good), it is reasonable to suggest that the steady and significant improvement in the disease situation in Co. Monaghan is due in part, at least, to the rigorous application in this county of the Department's interim wildlife policy. However, it is acknowledged that the wildlife intervention is just one of a range of disease control measures brought to bear in Co. Monaghan, and that these other measures have also had an impact in reducing disease levels in the county.

Nationally, as discussed earlier in this chapter [6.3.1, 6.3.2], disease levels have fallen significantly since peaking in 1998/1999. While this steady improvement in the disease situation cannot be attributed solely to the wildlife strategy, the fact remains that the introduction of this strategy was by far the most significant change to disease control measures undertaken during the period under review. The existence of a wildlife reservoir is recognised to represent a major impediment to the eradication of tuberculosis in cattle in countries and regions both within the European Union (e.g. Northern Ireland, Great Britain) and elsewhere (e.g. New Zealand, Michigan State) and the Department's interim wildlife strategy represents a pragmatic response, based on sound science, to this reality.

In the long term, the Department will continue to invest in the research and technology necessary to produce an efficacious vaccine for use in badgers, a development which would obviate the need for the interim badger control strategy. Ongoing monitoring is essential to ensure that the considerable investment in the interim wildlife strategy is bringing about the desired results for disease levels in cattle in a cost-effective manner. In this regard, the Department is continuing to proactively evaluate the effectiveness of badger removal by commissioning and undertaking research designed to build on the evidence provided by the Four Area Project and other research already undertaken (see below).

6.4.6 Recent and forthcoming research

<u>Four Area Project</u>

In addressing the issue of a possible 'perturbation' effect in the Four Area Project, Irish researchers noted that the intensity of badger removal in the reference areas of the Four Area Project, for example, was very much lower than that reported by Donnelly et al. in Great Britain[8], and so low as to render 'implausible' any relationship between badger removal, at the level of removal intensity recorded in Ireland, and confirmed restriction in the reference area (Griffin et al., 2005, 2005a). In addition, analysis of the results of the Four Area Project indicated no statistically significant risk of disease occurrence in the reference areas in the pre-study period, as compared to the study period. The results of the Four Area Project do not, therefore, provide any evidence for the existence in Ireland of a 'perturbation' effect.

<u>Study of targeted badger removal in Co. Laois, 1989-2005</u>

This recently completed study (Olea-Popelka et al, submitted) investigated the impact of the targeted removal of badgers on the subsequent bovine tuberculosis (BTB) status in cattle herds in Co. Laois. The study period was 1989-2005. For each of 122 targeted badger removal licenses, the index herd (that for which the license was granted) and the contiguous herds were identified. The contiguous herds were categorised into 4 different exposure groups based on their spatial proximity to the index herd and a comparison of the risk of a tuberculosis breakdown was conducted between these herds and herds in a reference group (located in areas where targeted badger removal did not occur). The study tested the hypothesis that the risk of a tuberculosis breakdown for herds in areas in which targeted badger removal was conducted does not differ from the risk for herds in areas in which targeted badger removal was not conducted. The principal conclusion of the study was that, in County Laois over the study period, targeted badger removal reduced the risk (increased the 'survival time') of a tuberculosis breakdown compared to those herds from which badgers were not removed (reference area). Furthermore, the study found no evidence of a negative impact on the risk of bovine TB among herds within a 500 m distance from the edge of any fragment of the index herd.

<u>Forthcoming research</u>

Forthcoming doctoral research to be carried out in Co. Monaghan will, inter alia, re-examine the interaction between badger capture and the prevalence of bovine TB in cattle studied by Olea-Popelka et al., but from the perspective of the local area under capture (capture block), rather than the herd, and using somewhat different parameters to define the spatial groupings of interest.

6.5 Research and Technology

6.5.1 The role of evidence in informing policy

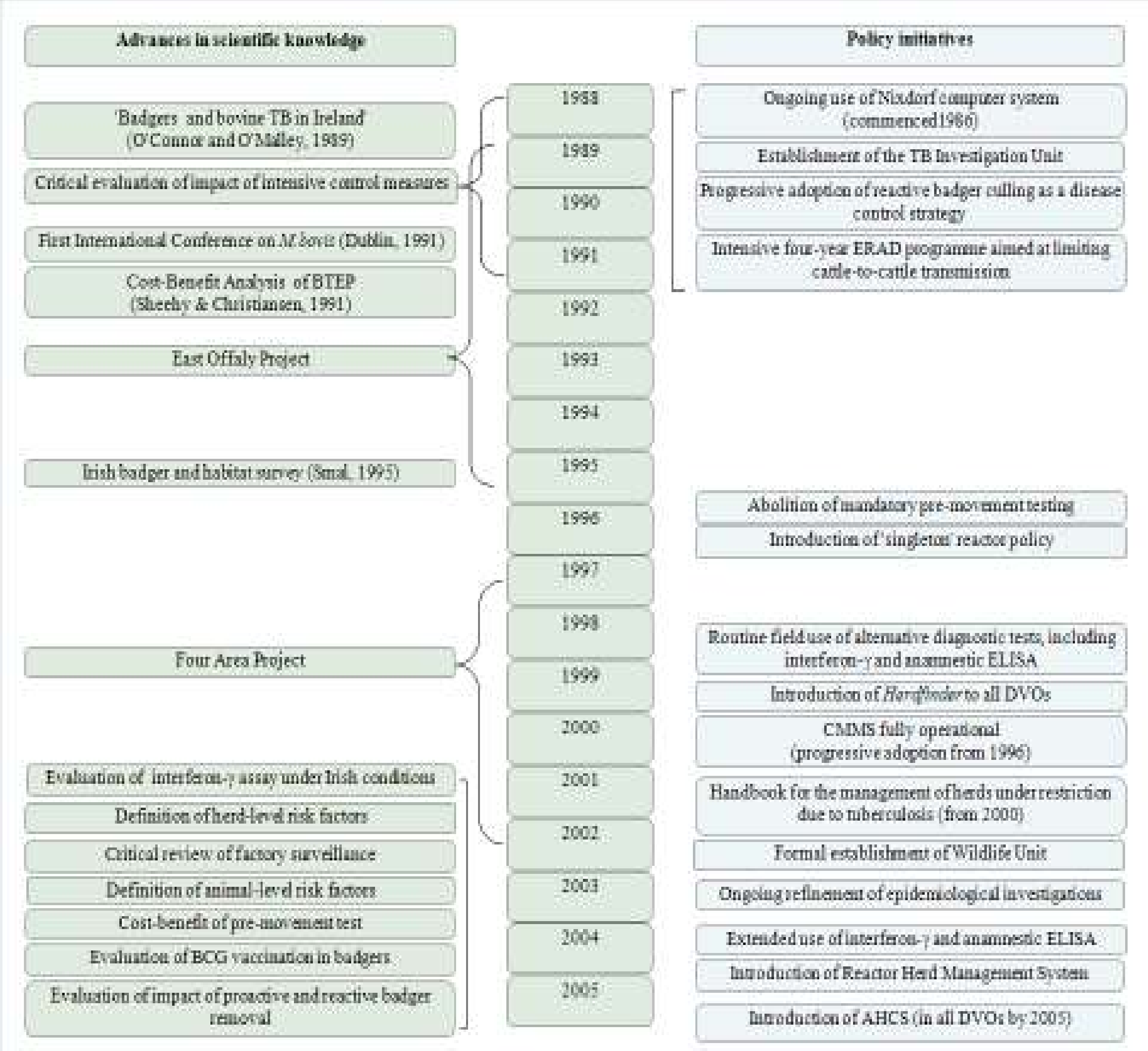
In the fields of human and animal health, evidence frequently takes the form of scientific knowledge, and particularly knowledge of disease epidemiology. However, although evidence arising from scientific research forms an important element of the policy formation process, it is far from the only one; a wide variety of political and socio-economic influences also come to bear on the process, strongly influencing the eventual shape of policy. For this reason, it can be argued that animal health policy is more accurately described as science-informed rather than science-based (More and Good). In the following paragraphs, the role of research in shaping more effective policy-making in relation to the BTEP will be explored.

6.5.2 Research and TB policy

The research inputs into the Department's TB eradication programme have already been described [4.5]. In examining the role played by research in the development of an effective TB eradication policy, it is useful to distinguish between that focused on disease transmission between cattle and that focused on investigating transmission between cattle and wildlife reservoirs (More, 2007). Disease control policies, which up until the late 1980s had focused almost exclusively on disease transmission between cattle, generally developed ahead of scientific advances in the field of cattle-to-cattle transmission of bovine tuberculosis, and the role of science was therefore largely that of analysing and refining existing policy. In the field of investigation of disease transmission between wildlife and cattle, by contrast, research largely preceded the development of policy and found itself, therefore, in the role of analysing evidence and presenting the Department with broad policy options for the development of future policy. These functions – the analysis of evidence and the development of options – should be carefully distinguished from each other (ibid.). Figure 6.14 presents a timeline showing advances in scientific knowledge of the epidemiology of bovine tuberculosis, on the one hand, and the adoption of new technology and policies aimed at enhancing disease control and eradication measures, on the other.

The economic benefit of research focused on food safety, animal welfare (including health) and environmental matters is not readily amenable to economic quantification. This may be due to the inherent difficulty in quantifying outcomes in these areas, or because of long lead-times to their detection. Measurement may also be complicated by the tendency to focus on a particular research outcome because it is measurable, rather than because of its importance (Boyle et al.). Nonetheless, it is clear that research carried out by and on behalf of the Department has had a strong effect on the formation of policy in relation to bovine TB and has been instrumental in overcoming many of the factors previously identified as constraining progress towards eradication of the disease. It is noteworthy, in particular, that advances in research and technology have been instrumental in delivering solutions or partial solutions to the three principal constraints to eradication, identified at the end of the intensive eradication programme undertaken in the period 1988-1991 as being: (i) the absence of a vaccine for TB in badgers and/or cattle; (ii) a laboratory-based diagnostic test and; (iii) a computerised movement permit system period [1.5.5].

Figure 6.14 Advances in scientific knowledge and policy initiatives



Source: Adapted from More and Good

6.6 Reactor Collection Service

Quite apart from the efficiency gains arising from the operation of a centralised reactor collection service [5.10], the operation of such a service is also likely to improve the effectiveness of disease control measures. In the absence of such a centralised service, farmers whose herds were affected by bovine tuberculosis would have to negotiate a price with one of the limited number of suitable slaughter premises across the country and travel what would, in many circumstances, be significant distances in order to deliver the reactor animals from their herds to these premises. These logisitical impediments, together with the likely depression of salvage values, would quite conceivably result in significant delays in the surrender of reactor cattle, with consequent adverse effects on the containment and resolution of disease on affected farms.

6.7 *Post-mortem* surveillance

The *post-mortem* surveillance of cattle presented for slaughter is a legal requirement applicable to all EU member states engaging in intra-community trade in fresh meat (EC 2004/854). Factory surveillance of cattle presented for slaughter plays an important role in ensuring that the carcasses of animals infected with bovine TB do not enter the food chain. Carcasses of animals with localised lesions can, however, enter the food chain, following the removal of any affected parts, without posing any known threat to food safety (EFSA, 2003). *Post-mortem* surveillance is also an important adjunct to the extensive tuberculin testing programme carried out on the live animal. By enabling the detection of infection during the period between annual tests, it facilitates the rapid resolution of the problem in the herd and enhances the confinement of infection to the source herd. Although field surveillance is responsible for the detection of the majority of disease episodes, the rate of detection at *post-mortem* inspection is significant, accounting for between 24% (1998) and 37% (2006) of all new herd breakdowns in recent years, notwithstanding that approximately 80% of the breakdowns revealed in this manner do not reveal any other infected animal (see below). Indeed, in the final stages of eradication, it would be expected that post-mortem surveillance would become the most effective means of detecting residual infection in herds and that, if freedom from bovine tuberculosis were to be achieved, such surveillance would be the most effective single method of proving that disease freedom is maintained (Corner et al., 1990).

Because expenditure on *post-mortem* surveillance for bovine tuberculosis can be treated as a sunk cost from the perspective of the BTEP [5.13], and is likely, in any case, to be of a very low order compared to the cost of detection in the live animal, it may be tempting to suggest that significant cost savings could be achieved by scaling back field surveillance in favour of *post-mortem* examination. There are, however, a number of reasons why such a course of action is neither possible nor desirable under present circumstances.

Firstly, as discussed previously in this chapter [6.3.4], in order to meet the requirements of Directive 64/432EEC as they apply to member states whose average herd incidence exceeds 1%, Ireland is required to carry out surveillance testing using the intradermal test on the national herd on an annual basis.

Secondly, the sensitivity of post-mortem inspection for bovine tuberculosis is considerably lower than the sensitivity of the SICTT intradermal test. This lower sensitivity is a function of the objective of veterinary post-mortem inspection, which is to determine the suitability of the carcase for human consumption by examination for the presence of visible evidence of zoonoses, including tuberculosis. Australian research (ibid.) has shown that standard post-mortem inspection procedures resulted in the detection of lesions in less than 20% of a randomised sample of reactor cattle and that when reactor cattle were subject to a more detailed post-mortem examination, the rate of detection rose to 52%. Failure to detect a lesion during *post-mortem* examination is of greatest significance in cattle with single lesions because if this lesion is not detected, there will be no further opportunities to detect tuberculosis in that animal. Based on results obtained using the detailed post-mortem examination, over 65% of cattle in this study were found to have single lesions. Separate research (Whipple et al.), carried out in the United States on a group of 30 cattle from an infected herd, found that 4 of the 15 infected cattle in the study would probably not have been detected during routine slaughter surveillance. 14 of the 15 infected cattle were, however, correctly identified as being infected based on the parallel interpretation of the caudal fold test (an intradermal test of relatively low sensitivity and poor specificity) and the IFN-γ assay. The authors concluded that not all infected cattle develop grossly visible lesions in sites that are routinely examined and that the identification of infected cattle by *post-mortem* inspection becomes progressively more difficult as the prevalence of tuberculosis decreases.

Finally, in assessing the contribution of disease detection by *post-mortem* surveillance in the context of the overall Programme it is necessary to take account of evidence regarding the potential pathogenicity of such animals prior to slaughter. Epidemiological data indicate that no further reactors are found at the subsequent tuberculin test in approximately 80% of herd breakdowns first detected by means of factory surveillance (Byrne). Such low infectivity for other cattle in the herd may be a consequence of the fact that, in many such cases, the animal's immune response has been successful in 'resolving' the infective process. It also reflects the fact that the potential for development of infective, 'open' cases of tuberculosis is constrained as a consequence of the comprehensive programme of live animal surveillance, in which each animal is subjected to an annual tuberculin test.

6.7.1 Performance of Irish meat factories

A recently published review of the relative performance of Irish meat factories in detecting lesions among attested cattle[9] slaughtered during 2003 and 2004 (Frankena et al.) has demonstrated the existence of marked variations between factories in the rate of detection of suspect lesions of tuberculosis and in their subsequent confirmation in the laboratory. The average unadjusted risk of submission for laboratory examination of a suspect lesion for all factories was 22 per 10,000 attested animals slaughtered, ranging from 0 to 58 per 10,000. The average unadjusted risk of these suspect lesions subsequently being confirmed as being tuberculous was 63%, ranging from 34.3% to 86.3%. The researchers concluded that these variations were less likely to have been attributable to differences in the risk profile of the cattle slaughtered at each factory than to inherent differences between the factories. Separate research cited by the authors suggests that such variations may be attributed to factors such as differences in line speed, light intensity, the skill of the inspector, their workload, or their motivation (Collins, 1997).

The substantial variation between the submission and confirmation risks of different factories described by Frankena at al. indicates that practice in Irish slaughter plants in the period under observation relating to the submission of suspect lesions is not uniform. It also raises the possibility that the rate of detection of tuberculous episodes via *post-mortem* examination in that period actually understates the true rate at which attested, but infected, cattle were being presented for slaughter. However, the principal effect of any variability between slaughter premises in the rate of detection of TB is on the timing, rather than the number, of disease episodes detected. The comprehensive parallel system of field surveillance ensures that disease continues to be detected in the live animal at farm level and that the risk to human health is consequently minimised, in line with best practice as recommended by the European Food Safety Authority (2003). Proposals, made in Chapter 7, to adopt performance indicators to monitor the rates of submission of suspect TB lesions by individual slaughter premises provide one means of tracking the extent of variable factory performance over time and, consequently, of optimising the effectiveness of *post-mortem* disease surveillance.

6.8 Programme impact

The impact of a programme is the difference it has made to targeted beneficiaries and society as a whole over the medium to long-term, having made allowances for what would have occurred anyway in its absence. Evaluating programme impact requires some exploration of 'additionality' and the manner in which benefits are distributed. These are discussed in the following sections.

6.8.1 Additionality

The success of government intervention in a given target area is usually assessed in terms of its 'additionality'. This is its net, rather than its gross, impact after making allowances for what would have happened in the absence of the intervention. Additionality can also be thought of as a 'supply side' or 'structural' impact, which operates by altering the productive capacity of the economy (HM Treasury). The supply side benefit of the BTEP is mediated through two mechanisms. Firstly, by establishing the conditions necessary to allow the exportation of bovine animals to occur, the Programme facilitated the growth of the Irish cattle industry far beyond the size that would have been required to service exclusively domestic consumption. The enlarged national cattle industry in turn exerts a 'multiplier'[10] effect on 'downstream' activities such as beef processing and marketing. Secondly, by reducing TB-related animal production losses, the Programme increases the productivity of cattle-rearing, thereby raising output. The various components of 'additionality' as they relate to the BTEP are discussed below.

<u>Deadweight</u>

'Deadweight' refers to outcomes that would have occurred in any case, without intervention by government (ibid.). In Chapter 3 [3.2.1] it was argued that the existence of strong negative externalities in the control of bovine tuberculosis and the high transaction costs involved in establishing a national eradication programme suggest that a programme for the eradication of bovine TB would not have come into existence had the state not become involved. The dearth of international examples of bovine TB eradication programmes operated without any state involvement lends further strength to this contention.

Displacement

'Displacement' is said to occur when the creation of a positive project or programme output leads to a loss of output elsewhere (Mulreany). There is no doubt that the staff complement of the Department is today larger than it would have been in the absence of the Programme. Furthermore, the number of PVPs grew strongly over the course of the 1960s in response to the requirement for additional veterinarians to carry out tuberculin testing right across the national territory. The cost of these additional resources, which is indicative of the loss of output elsewhere in the economy, is a function of the prevailing labour market situation. Sheehy and Christiansen (1991) put the argument in relation to Department staff in the following terms:

> If the personnel on the BTE Scheme are taken off other productive work which now remains undone because of the Scheme, then the national cost involved is the value of the work left undone. In a competitive market situation this is accurately measured by the salaries and fees paid to the personnel. However, if the personnel would have been unemployed in the absence of the Scheme the national cost is totally different; it is now the cost of training the relevant personnel to carry out the Scheme.
>
> (ibid.)

Given that the labour market situation in Ireland over the period under review can be characterised as 'competitive', the cost of employing personnel who would not have been employed in the absence of the BTEP can be represented as the salaries and fees of these employees. With regard to private veterinary practitioners (PVPs), Sheehy and Christiansen state that the 'opportunity cost of veterinary people to the Irish BTE Scheme was very low'. This is based on the assumption that veterinary graduates would have been highly unlikely to have become an unemployment burden on the state in the absence of the BTEP, given the high likelihood that they would have found employment in other jurisdictions. The consolidation of EU legislation[11] relating to the mutual recognition of veterinary surgeons' qualifications and its progressive transposition into member states' domestic legislation can only have served to improve such mobility over time, further strengthening this contention.

Leakage

The final factor to be taken into account in the calculation of additionality is that of 'leakage', which occurs when a programme results in benefits outside of the spatial area or group that the intervention is intended to benefit (HM Treasury). In the context of the programme under review, the various compensatory mechanisms create the potential for leakage in situations in which the benefits available from compensation exceed the economic losses incurred. Such conditions may encourage illicit rent-seeking behaviour by a tiny minority of individuals who are prepared to defraud the Department by falsifying reactors so as to attract compensation in non-diseased herds, or to maximise the extent of the compensation available in herds that have been affected by bovine tuberculosis. The scale of such unintended benefits is thought to be small and is, in any case, poorly quantifiable.

6.8.2 Distribution of benefits

Market access

The benefits of market access accrue in the first instance to the farmer producer and to the processing sector, diffusing from there to benefit the wider economy and society as a whole. Society benefits from such trade to the extent that the resources absorbed by agriculture in general, and livestock farming in particular, could not be more productively employed elsewhere in the economy. Within the overall trade in beef and beef products, the component representing the live trade benefits the farmer-producer to a greater extent than the domestic processor as additional buyers are positively associated with producer prices for livestock [2.2.1].

Animal productivity

To the extent that the absence of TB allows cattle to express their full genetic potential, the reduced costs of production and the increased value of the animal's output are private benefits to the farmer. However, there is also an increase in economic productivity at the national level, which allowed the national herd to increase rapidly in size between the late 1960s and early 1970s (see discussion on additionality, above). The increased economic activity associated with this expansion of the supply side benefits society at large.

Public health

The degree to which the BTEP benefits the health of the general population is limited, given that the pasteurisation of milk and dairy products and veterinary public health controls on meat and meat products negate the risk of *M. Bovis* transmission *via* the food chain. Nonetheless, the BTEP, by reducing and controlling the incidence of the disease in cattle mitigates the risk of transmission between cattle and those who have direct contact with their untreated products, including unpasteurised milk (Thoen et al.). Given that the principal public health risk of bovine tuberculosis is to farmers, or those who have regular contact with cattle, the human health benefits of the programme accrue to this section of society to a greater degree than they do to the population at large.

6.9 Continued relevance

Evaluation of the continued relevance of a public programme requires analysing the extent to which changes in the external environment in the period since its inception may have undermined the relevance of programme objectives (ESRI).

The Programme today continues to meet the needs that led to its establishment over 50 years ago. Now, as then, the imperative of ensuring access to European and world markets is a legitimate concern of the Department and of government. Although the characteristics of the marketplace have changed in the period since the Programme's inception, the legislative environment within which it operates has remained fundamentally unaltered since Ireland's accession to the EU in 1973. Such changes as have occurred have been in the direction of reinforcing the importance of the EU marketplace as a destination for Irish beef and cattle exports. In 2006, EU markets accounted for over 96% in value terms of all beef exported from this country and for practically 100% of live cattle exports. Compliance with the Community *acquis* insofar as it relates to trade in cattle and their products is thus an essential component of the government's strategy of supporting the international competitiveness of the Irish agri-food industry.

Outside of the jurisdiction of the European Union, competition for entry into third country markets is intense and globalised, and is subject to increasingly stringent health certification requirements. The protocol drawn up for the export of beef into Ireland's most important third country market – the Russian Federation – specifies that meat and raw meat preparations are to be obtained from the slaughter and processing of clinically healthy animals, originating from premises officially free from infectious animal diseases (including bovine tuberculosis) and that veterinary *post-mortem* inspection reveals no evidence of these diseases. It is clear from this example that, in the absence of a programme for the control and eradication of bovine tuberculosis, Ireland's beef and live animal trade both within the EU market and outside it would be severely curtailed, or rendered unviable.

Stakeholders generally accept the relevance to the contemporaneous programme of the interim and long-term objectives, although they may diverge significantly in their expectations as to the extent to which these have been achieved and the timescale over which significant further progress eradication may be attained. It is clear that, for many, the achievement of measurable reductions in disease incidence in the interim period and the creation of the conditions that will prepare the way for eventual eradication of bovine TB are critical to maintaining the long-term credibility of the BTEP.

<u>Programme review</u>

Failure to reappraise rationale on a frequent basis may result in an undermining of validity over time as shifts in the external environment attenuate or completely overcome the needs the programme originally set out to address. The BTEP – in part due to the historically controversial nature of the programme – has, however, been subject to numerous reviews, which collectively have encompassed all aspects of the evaluative process – rationale, efficiency, effectiveness, impact and continued relevance. Some of the more influential reviews to which it has been subject are mentioned in Chapter 1 [1.5.8] and discussed in greater detail in the literature review accompanying this report.

6.10 Key Findings

- The On-Farm Market Valuation Scheme (OFMVS) provides an effective means of ensuring that herdowners receive a fair price for reactor cattle.

- Depopulation of herds that have undergone a severe breakdown is not an effective means of resolving such breakdowns in Ireland, because, in the great majority of cases, repeat infection originates from an infected local wildlife source rather than from within-herd transmission.

- The indirect losses incurred during a breakdown, which the Income Supplement is designed to partially offset, are likely to vary over the course of the year, being greater during the grass growing season when feed costs are low and productivity is at its highest, than during the winter months, when feed costs are relatively high and productivity is low.

- A proportion of the recipients of payments under the Hardship Grant Scheme may not have incurred feed costs additional to those that would pertain if their herds were not restricted. Furthermore, analysis of the rates payable under the Hardship Grant Scheme show these to be relatively undifferentiated as between animal categories, despite the substantial differences in winter feeding costs across these categories. The grant does not take account of any increases in value resulting from overwintering and does not differentiate between the stable and transient components of the herd.

- The rate at which reactors were identified over the period under review fluctuated within a range of 23,000 to 45,000 per annum and averaged 32,000 for the entire period. However, the average annual extraction rate in the most recent 5 year period (2002-06), at 26,000 reactors, was 32% below the average for the preceding 5 years.

- Bovine TB levels, as measured by reactor numbers, were successfully maintained at or below the 5-year exponential moving average (EMA) for 8 of the 11 years under review, the exceptions being 1998 and 1999, when they rose significantly above these values, and 2000, when they remained slightly above the EMA. Herd incidence exceeded the EMA in four periods (1998-2001) and APT in three periods (1998-2000).

- Approximately 85% of the tuberculin testing carried out in the BTEP is required to fulfil the terms of the trade Directive 64/432/EEC.

- The cost-effectiveness of those tuberculin tests that are not specifically required for trade under the terms of Directive 64/432/EEC is greater than that for surveillance testing carried out in compliance with the Directive.

- The Gamma Interferon (IFN-γ) assay has proven itself to be a very effective adjunct to the intradermal test in certain limited cirumstances. Expanding the use of the assay, or any alternative test that may be developed in the future, will necessarily have regard to the cost-effectiveness of such test and the need to maintain acceptable levels of test accuracy.

- Evidence from research carried out in Ireland and Great Britain confirms that badgers contribute significantly to the disease in cattle.

- The badger vaccine programme is a key component of the strategy to eradicate bovine tuberculosis. A field vaccination trial, about to commence, is a major piece of research that will continue at least until 2013. A successful outcome of the trial is a prerequisite for the incorporation into the BTEP of a national programme of badger vaccination.

- In the absence of a viable field vaccine for badgers, it has been necessary to develop an interim strategy for dealing with infection from wildlife sources. The strategy adopted is underpinned by the findings of research already undertaken and it will continue to undergo scrutiny in the light of findings from current and planned research. While the steady reduction in the incidence of the disease from 2000 onwards cannot be attributed solely to the interim wildlife strategy, its introduction was by far the most significant change to disease control measures undertaken during the period under review.

- The Department's research and technological development programmes have been instrumental in providing the evidence base that guides policy development in relation to bovine TB and the means to overcome many of the currently known constraints to eradication. Much of the current research programme is aimed at overcoming the constraint caused by infected wildlife, which remains a continuing and substantial obstacle to the eventual eradication of bovine TB.

- The operation of a centralised Reactor Collection Service enhances the effectiveness of disease control measures.

- The operation of a parallel system of surveillance for tuberculosis in the live animal and at post-mortem inspection is a legal requirement under EU legislation and is a more effective means of detecting disease than would be possible using either approach in isolation.

- Irish research has pointed to a degree of variability between individual slaughter premises in the detection of tuberculosis.

- The net impact of the Programme has been to facilitate the growth of the Irish cattle industry by creating and enhancing export opportunities and by improving the productivity of cattle rearing.

- The benefit of improved market access accrues to the farmer producer and to the processing sector in the first instance, while the benefits of improved animal productivity and public health accrue primarily to the farmer producer. Society at large also benefits from the Programmes impacts in all three areas.

- The requirement to access export markets, which brought about the creation of the Programme in the 1950s, continues to operate today, despite the considerable changes in the scale and structure of the cattle industry and the market for cattle and beef in the interim.

- Legislation governing intra-Community trade in cattle and cattle products has remained fundamentally unchanged since Ireland's accession to the EEC in 1973.

- The present-day validity of the Programme is enhanced by virtue of the extent to which it has been subject to review.

6.11 Conclusions

- In the period under review, the BTEP has met its interim objective of controlling bovine tuberculosis at levels consistent with maintaining trade in bovine animals and their products. Considerable progress has been made in overcoming the constraints to eradication through investment in research and technology; however, the existence of an infected wildlife reservoir remains a continuing and substantial obstacle to the eventual eradication of bovine TB.

- Although the On-Farm Market Valuation Scheme (OFMVS) is somewhat more expensive to operate than its predecessor – the Reactor Grant Scheme (RGS) – it is more equitable and effective than the latter as it better reflects market value and reduces distortions in the market for reactor cattle.

- The Depopulation, Income Supplement and Hardship Grant schemes, which are unique to Ireland among the countries examined in the preparation of this review, serve a very useful function in alleviating the income losses incurred by herdowners as a result of a disease breakdown. However, there would appear to be a need to review the rates of grant, in particular, to better target those categories of animals that give rise to the biggest income loss.

- The rates of grant available under the Income Supplement Scheme do not reflect the seasonal variation in the income loss arising from the removal of reactors or the different income loss associated with the different categories of animal removed.

- The rates currently payable under the Hardship Grant may not adequately reflect the variations both in the cost of feeding cattle over the November-April period or the increase in value of the various categories of animals over the same period.

- Those tuberculin tests that are carried out over and above the requirements of the Trade Directive are cost-effective and should be retained, as should those measures aimed at improving the targeting of testing carried out under the Programme.

- The IFN-γ assay is believed to contribute to the cost-effective resolution of TB breakdowns, in conjunction with the intradermal test, in certain circumstances. However, the lower specificity and the higher unit cost of the assay when compared to the SICTT result in some additional costs. Quantification of certain of the benefits associated with the use of the assay would assist the ongoing refinement of the protocols governing its deployment.

- The significant role played by infective badgers in maintaining bovine tuberculosis in Ireland justifies both the level of investment in the development of a badger vaccine and the operation of a targeted interim wildlife strategy.

- While the significant reduction in the incidence of TB since 1998 may be attributed to a number of factors, the introduction, in 2002, of the interim wildlife strategy, can reasonably be regarded as having made an important contribution to this improving situation.

- Through its positive impact on trade in bovine animals and their products, on the productivity of bovine animals and on the protection of human health, the Programme confers benefits on farmers, processors and on society at large.

- The maintenance of a Programme for the Eradication of Bovine TB continues to be relevant to Ireland because, in conjunction with certain other animal health measures, it provides the guarantees necessary to enable Irish cattle and their products to access the EU and third country markets.

6.12 Recommendations

Recommendation 7

The rates of grant available under the Income Supplement Scheme should be reviewed to better reflect the seasonal variation in the income loss arising from the removal of reactors and the different levels of income loss for the different categories of cattle. The continuing eligibility of herdowners for this scheme should be reviewed after a period of 6 months on the basis of a comparison between herd composition and enterprise type at that time and the position prior to the breakdown.

Recommendation 8

The rates of grant payable under the Hardship Grant Scheme should be reviewed, in particular, to better target the grants on those cattle where the cost of feed significantly exceeds the increase in value during the November-April period. The scheme should also be restricted to herdowners who can demonstrate that they have additional cattle and feed requirements in their herds as a result of the restriction imposed for disease control purposes.

Recommendation 9

Research and technological development remain crucial to the resolution of the factors that continue to constrain progress towards the eradication of bovine TB and the Department should, consequently, maintain its support for these measures.

Recommendation 10

The Department should reassess its policy in relation to the deployment of IFN-γ assay in light of the results of a study, currently being undertaken, on the effectiveness of the test in shortening restriction periods.

TABLES

Unless otherwise stated, data in these tables are sourced from the Department of Agriculture, Fisheries and Food

Table 6.1 TB episode classification Co. Monaghan (2000-2006)

No. of standard reactors per episode	2000	2001	2002	2003	2004	2005	2006
0	24.5%	36.0%	28.5%	24.7%	34.2%	40.2%	50.5%
1	31.6%	21.7%	33.0%	32.8%	26.4%	21.5%	18.8%
2	15.4%	12.6%	12.1%	11.5%	13.4%	10.0%	9.7%
3	6.9%	6.7%	6.1%	8.7%	6.9%	5.9%	5.4%
4-10	18.2%	16.0%	13.9%	16.4%	15.6%	13.7%	11.3%
>10	3.4%	6.9%	6.4%	5.9%	3.5%	8.7%	4.3%
	100%	100%	100%	100%	100%	100%	100%
No. of episodes	**592**	**419**	**330**	**287**	**231**	**219**	**186**

Table 6.2 Selected TB data Co. Monaghan (1996-2006)

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Herds	4,870	4,830	4,750	4,520	4,530	4,350	4,380	4,350	4,365	4,375	4,446
Herd tests	5,900	6,050	6,300	6,750	6,400	6,590	6,040	5,490	5,190	5,100	4,200
Animal tests	######	######	######	######	######	######	######	######	######	######	######
Reactor herds	592	455	698	698	578	435	332	300	250	197	159
Reactors	2,629	1,999	3,626	3,550	2,400	2,000	1,360	1,600	914	1,208	695
Herd incidenc	10.03%	7.52%	11.08%	10.34%	9.03%	6.60%	5.50%	5.46%	4.82%	3.86%	3.79%
County APT	8.10	6.40	10.20	9.30	6.70	5.70	4.30	5.50	3.30	4.30	2.48
National APT	3.00	2.90	4.10	4.20	3.80	3.40	3.20	3.00	2.70	2.60	2.50

NOTES

[1] Commission Regulation (EC) 1857/2006

[2] While farmers pay for one test yearly, they are not always Type 1. Farmers may pay for a number of other test types (e.g. Types 5 and 8) which substitute for the annual surveillance test.

[3] The IFN- γ assay is recognised under Commission Regulation (EC) 1226/2002 which amends Annex B of Directive 64/432/EEC. The test is recognised in national legislation under the TB Order (S.I. 308 of 1989 as amended by S.I. 161 of 2000).

[4] High-risk herds are those in which there is evidence of within-herd proliferation of tuberculosis. They are defined as being those herds with two or more infected animals over the course of the episode (duration of restriction under the TB Order), as evidenced by the detection of lesions or by animals failing the SICTT at standard interpretation.

[5] Except those herds engaged solely in sourcing animals for finishing for slaughter which do not pose a risk in terms of disease spread.

[6] http://www.fs.fed.us/r5/modoc/conditions/index.shtml; http://www.angus.org/pr/clipart.html; www.landcare.demon.co.uk/Badger.jpg

[7] Ireland ratified the Convention in April 1982.

[8] 0.07 badgers/km2/year in the Four Area Project as opposed to 0.87 badgers/km2/year reported by Donnelly et al.

[9] Attested cattle are those cattle with a clear individual and herd TB status.

[10] A 'multiplier' is a measure of the further economic activity, (whether output or jobs), resulting from the creation of additional local economic activity (HM Treasury).

[11] Council Directive 81/1057/EEC of 14 December 1981 supplemented Directives 75/362/EEC, 77/452/EEC, 78/686/EEC and 78/1026/EEC concerning the mutual recognition of diplomas, certificates and other evidence of the formal qualifications of doctors, nurses responsible for general care, dental practitioners and veterinary surgeons respectively, with regard to acquired rights.