5. Breeding programmes and techniques

Introduction

5.1 The emergence of BSE raised questions about whether the disease was attributable to modern breeding programmes and techniques, and, if so, whether any precautions or controls were needed. This chapter looks at the breeding policies that have led to the current makeup of the UK cattle population, which involves a brief discussion of the roles of the MLC and Milk Marketing Boards in livestock breeding and improvement. It describes the commonly used cattle breeding techniques of artificial insemination (AI) – there are well over two million inseminations in the UK each year – and embryo transfer, which generates around 10,000 calves per year. The chapter also describes how the cow’s breeding cycle can be manipulated by using injections of external hormones to ensure conception.

The UK cattle herd’s composition

Factors influencing breeding decisions

5.2 The genetic makeup of the national herd reflects decisions made by farmers and those in the breeding services industry. Farmers are responsible for day-to-day decisions on which cows and heifers to breed from, and which bulls to use. The main options available are:

- home-bred or bought-in cows and heifers mated with home-bred, bought-in, borrowed or imported bulls;
- artificial insemination of home-bred or bought-in cows and heifers using either semen from the UK, or imported semen from countries such as Canada and New Zealand (see paragraphs 5.13–5.14 and 5.20–5.33); and
- embryo transfer from home-bred or bought-in cows with proven milk production ability (see paragraphs 5.15–5.19)
  i. mated with home-bred or bought-in or borrowed bulls; or
  ii. mated by artificial insemination using semen from tested bulls or imported semen.

5.3 When deciding on breeding programmes, beef farmers aim to improve the weight and quality of beef produced at slaughter, and dairy breeding farmers mainly seek to increase or maintain the milk yield produced by the herd and its milk quality (assessed with reference to butterfat and protein content, for example).
5.4 Dairy farmers also try to obtain maximum value from surplus calves that are not needed as herd replacements, and use them instead for beef production. If dairy cows and heifers are mated with beef breeds such as Hereford, Charolais and Limousin, the resulting calves command a higher price since they produce a better beef carcass compared with Friesian and Holstein dairy calves. Such practices have produced a high incidence of crossbred beef cows in the national herd. These cows are mated with beef breeds (domestic and continental) to produce beef cattle for fattening.

5.5 AI allows cows to be inseminated by a bull with superior genes. Many different bulls are available on the market. Each has been progeny-tested for particular production traits such as milk yield, proportion of butterfat in milk, and ease of calving. The farmer decides which traits are most desirable for his or her farming purposes and buys in the appropriate bull’s semen.53

5.6 Until its demise in 1995, the Milk Marketing Board monitored genetic improvements in production traits of dairy cows, such as milk yield and butterfat. Since then the Milk Development Council has funded the Animal Data Centre (ADC) to undertake this task. Farmers can use this monitoring service to compare production in their herds with the national herd.

5.7 Despite the options available, when choosing a bull to sire calves, most farmers seek the same genetic characteristics. Extensive use of relatively few bulls has narrowed the gene pool in the national herd.54 For example, at a meeting of representatives of the cattle AI industry in 1987, it was noted that 19 sires had at least 80,000 daughters in 2,500 herds.55

**Breed trends**

5.8 By 1986 the British Friesian breed accounted for 86 per cent of the dairy herd in England and Wales, as a result of its dual characteristics of high milk yield and the suitability of its calves for beef production. Between 1986 and 1989 Friesian/Holstein crosses gained in popularity for milk production – see Table 5.1.56

---

53 Breeding directed towards desired traits may carry with it the need to feed high levels of concentrates to ensure the animals thrive and realise their genetic potential – see also paragraphs 6.19–6.25
54 S37B Foxcroft paras 27–8
55 YB87/08.05/4.2
56 Dairy Facts and Figures 1994, p. 36
Around 1986, the Hereford/Friesian crossbreed dominated beef suckler production. Furthermore, about a third of dairy cows and almost three-quarters of dairy heifers were inseminated with semen from beef breeds, such as Hereford and Aberdeen Angus. By 1989, the continental breeds Simmental, Limousin and Charolais were becoming increasingly important as crossbred or purebred suckler cows or as crossbred or purebred cattle for finishing. The rapid growth rate and lean carcasses of the crosses, and particularly the purebreds, increased their utility and popularity. Accordingly, the trend towards increased use of continental breeds continued into the 1990s.

Most of the early cases in the BSE epidemic were Friesian dairy cows, leading to initial suggestions that this breed might be more susceptible than other breeds to the BSE agent. However, an analysis in 1990 of confirmed cases from 1986 to December 1989 failed to demonstrate any increased susceptibility to BSE associated with breed type. It is now understood that the high incidence of BSE in Friesians was simply a reflection of their preponderance in the national herd.

### Table 5.1: Dairy cow breeds in England and Wales

<table>
<thead>
<tr>
<th>Breed of cow</th>
<th>1986</th>
<th>1989*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ayrshire</td>
<td>2.2</td>
<td>1.9</td>
</tr>
<tr>
<td>Friesian</td>
<td>85.8</td>
<td>74.5</td>
</tr>
<tr>
<td>Holstein</td>
<td>3.9</td>
<td>3.4</td>
</tr>
<tr>
<td>Guernsey</td>
<td>1.8</td>
<td>1.4</td>
</tr>
<tr>
<td>Jersey</td>
<td>1.6</td>
<td>1.7</td>
</tr>
<tr>
<td>Dairy Shorthorn</td>
<td>0.5</td>
<td>0.6</td>
</tr>
<tr>
<td>Friesian/Holstein cross</td>
<td>3.9</td>
<td>16.2</td>
</tr>
<tr>
<td>Friesian/Ayrshire cross</td>
<td>b</td>
<td>b</td>
</tr>
<tr>
<td>Other</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>TOTAL</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

*1989 is the most recent year that figures on breeds are available

b Included in 'other'

Source: Dairy Facts and Figures

5.9 Around 1986, the Hereford/Friesian crossbreed dominated beef suckler production. Furthermore, about a third of dairy cows and almost three-quarters of dairy heifers were inseminated with semen from beef breeds, such as Hereford and Aberdeen Angus. By 1989, the continental breeds Simmental, Limousin and Charolais were becoming increasingly important as crossbred or purebred suckler cows or as crossbred or purebred cattle for finishing. The rapid growth rate and lean carcasses of the crosses, and particularly the purebreds, increased their utility and popularity. Accordingly, the trend towards increased use of continental breeds continued into the 1990s.

5.10 Most of the early cases in the BSE epidemic were Friesian dairy cows, leading to initial suggestions that this breed might be more susceptible than other breeds to the BSE agent. However, an analysis in 1990 of confirmed cases from 1986 to December 1989 failed to demonstrate any increased susceptibility to BSE associated with breed type. It is now understood that the high incidence of BSE in Friesians was simply a reflection of their preponderance in the national herd.
Breeding management on farm

Fertility management

5.11 To achieve maximum annual output of milk from each cow, dairy farmers must ensure that each cow produces one calf per year. To this end, management of cow fertility has become an important aspect of dairy farming. Pregnancy lasts nine months, and cows are unlikely to recommence their ‘oestrus’ cycles less than two months from the date of calving. It is therefore generally agreed that the optimal average interval between calvings is 365 days. Calving is usually timed to occur in either autumn or spring, although in some herds, especially dairy herds, calves can be born throughout the year.

5.12 To ensure conception, mating needs to take place when the cow is in the fertile part of her reproductive cycle, that is, during oestrus. To get the timing right, the manipulation of ovarian activity is widely practised in livestock farming. There are two options for the controlling the timing of oestrus in cows or heifers:

i. an injection of prostaglandin (PG) to bring the cow into heat within three to four days; or

ii. administering progesterone to inhibit oestrus for a period of time, so that the cow comes into heat within two to three days of withdrawing the progesterone.

Use of artificial insemination on farm

5.13 Farmers in the UK have used AI since the 1940s, and by the end of 1950 there were almost 100 AI centres in operation serving over 60,000 farms. About 1.9 million inseminations were performed across all breeds in the UK in 1986, increasing to over 2.1 million by 1994. The vast majority of commercial dairy herds are now bred using AI.

5.14 AI services are regulated and subject to MAFF supervision to ensure high health standards and quality in the industry (see paragraphs 5.27–5.29).

Use of embryo transfer on farm

5.15 Embryo transfer involves transferring an embryo from one animal and implanting it in the uterus of another. It is a means of producing a large number of offspring from a single cow with desirable characteristics, such as high milk yield. It was introduced in the 1970s, and can now be carried out on the farm, non-surgically, and without anaesthetic.

Oeestrus is the period in which the cow is receptive to a male, usually referred to as in ‘season’ or ‘heat’ or ‘bulling’. It may precede or coincide with ovulation.

J Webster, Understanding the Dairy Cow, Oxford, BSP Professional Books, 1987, pp. 81 and 300


J Webster, Understanding the Dairy Cow, pp. 306–7

S130 Gracey para. 27; Black’s Veterinary Dictionary, 19th Edition, p. 25

Dairy Facts and Figures. Figures are not available for later years, and it should also be noted that the figures given exclude home inseminations, and may not include follow-up or repeat services in some organisations

S37B Foxcroft para. 28

Black’s Veterinary Dictionary, 19th Edition, p. 160; S467 Maddocks Appendix 5 para. 1
5.16 The technique involves administering gonadotrophins to the donor cow to cause superovulation. These can be either Pregnant Mare Serum Gonadotrophin (PMSG), or pituitary Follicular Stimulating Hormone (FSH).

5.17 It is important to synchronise the donor’s and recipient’s oestrus, which may involve the use of hormones (see paragraph 5.12). When oestrus occurs, insemination of the donor cow is carried out two or three times. Embryos are collected from the donor cow seven or eight days after insemination, and each is transferred to a surrogate cow, which carries the embryo for the rest of the pregnancy.68

5.18 The Inquiry has received conflicting views on the source of FSH used for inducing superovulation in embryo transfer. On the one hand, it would appear that cattle pituitaries were used to prepare FSH. In the Veterinary Record in July 1988, members of the Veterinary Products Committee advised against this practice, in view of the possible risks of transmission of BSE.69 Dr Thomas Little, Chief Executive of the Central Veterinary Laboratory (CVL), also thought that cattle tissue might have been used to prepare FSH.70 On the other hand, Mr Harry Coulthard, a veterinary surgeon, said that using cattle pituitaries to produce FSH had been considered in the past, but that the cost and difficulty in doing so in comparison with using pig and sheep pituitaries was prohibitive. Accordingly, he was certain that no cattle-derived FSH had been used in embryo transfer.71

5.19 If cattle pituitaries had been the source of FSH, their use could have had implications for the transmission of BSE. The use of cattle products as raw materials for animal and human medicines is discussed in vol. 7: Medicines and Cosmetics.

Commercial breeding services

Artificial insemination techniques

5.20 In a normal mating, a bull produces up to 500 times more semen than is required to enable a cow to conceive. AI involves the collection, dilution, and storage of semen, and then the insemination of many cows from one ejaculate.72

5.21 Once collected, semen is divided into fractions and injected into the cervix or uterus of a cow in oestrus, or, in commercial practice, diluted 20 times or more and distributed into plastic tubes, or ‘straws’, to be used when necessary.73

5.22 Semen can now be stored for years using modern freezing techniques. Glycerol is added to the sperm diluent, which allows the sperm to withstand freezing without losing their fertility when thawed. Diluted semen is now commonly stored and frozen using liquid nitrogen.74
Artificial insemination services

5.23 Breeding programmes throughout the 1980s relied on progeny-testing of well-bred young bulls to enable the best to be returned to stud as mature sires for widespread AI use. Current breeding programmes rely on similar testing systems.

5.24 First, the government State Veterinary Service (SVS) approves young bulls for a strictly limited number of progeny-test inseminations. About 1,000 straws of semen are produced from the bulls soon after entry into an AI centre. About 750 from this collection are used for the progeny-testing. After the semen required for these tests has been collected and frozen, the bull is ‘laid off’ for five to six years until its breeding worth has been established by lactation records in about 40 to 50 daughters.

5.25 Only the very best of the progeny-tested young bulls are returned to stud for extended use. Those bulls then complete ‘many tens of thousands of inseminations’. However, if a bull is thought to have exceptional genetic merit then several thousand straws may be collected before the progeny-test is complete in case the bull dies before completion. As part of progeny-testing the bulls are backcrossed with daughters to test for genetic mutations that lead to disease. They are not tested for mutations of the prion protein gene or other genetic mutations.

5.26 In January 1990 MAFF introduced a policy to eradicate BSE-infected bulls from the approved bull scheme. If BSE was confirmed in a bull, its approval was suspended, and semen already collected from that bull could not be used. If BSE was confirmed in a bull’s dam or surrogate dam, it would be left to the owner’s and AI centre’s judgement as to whether to continue using semen from that bull. The scheme is discussed in further detail in vol. 5: Animal Health, 1989–96.

Regulation of artificial insemination

5.27 The Artificial Insemination of Cattle (Animal Health) (England and Wales) Regulations 1985 govern the animal health aspects of AI. These Regulations:

... prohibit the collection of semen for processing unless from an approved bull. They also prohibit the evaluation, processing, quarantine, storage and supply of semen for use in AI except under the authority of licences granted by a Minister, and the premises at which the above functions are carried out must be licensed for the purpose. Farmers wishing to store bull semen for use on their farm must also obtain a licence.

5.28 Veterinary officers inspect and report on the suitability of premises before a licence is issued under the Regulations, and periodic inspections are carried out to ensure continued compliance.
5.29 Before approval for AI use, bulls are required to meet specific veterinary standards and are examined for this purpose by an SVS veterinary officer. Bulls at AI centres are also subject to periodic examinations and tests by the SVS. They are tested for a variety of ailments including tuberculosis, brucellosis, enzootic bovine leukosis, trichomoniasis, and campylobacteriosis.

**Artificial insemination centres**

5.30 Up until 1994 the Milk Marketing Boards and the Department of Agriculture for Northern Ireland (DANI) operated about 120 AI centres around the UK. The centres, particularly in England and Wales, were run in conjunction with breeding units for bull rearing, progeny-testing units, and semen quarantine, storage and distribution units. In addition, AI services were provided by a small network of independent AI centres in the UK, for example, Associated AI Centres in England and Wales.

5.31 The AI centres stored semen, and provided skilled technicians to visit the farm to inseminate the farmer’s cows. A farmer needed to become a member of the AI centre to receive services. Membership was open to beef breeders as well as milk producers.

5.32 Abolition of the Milk Marketing Schemes in 1994 and the subsequent disbanding of the Boards led to independence for their breeding and production services. Genus Limited became responsible for the Board’s services in England and Wales, while Scottish Livestock Services took over from the Scottish Milk Marketing Board’s Livestock Division.

5.33 Only inseminators from AI centres are licensed to perform inseminations on a commercial basis, but farmers or staff can attend an approved training course and be licensed to carry out inseminations on their own farm. The local AI centre makes deliveries of semen, and provides liquid nitrogen top-ups for storage. In March 1986 approximately 2,400 farms in England and Wales held storage licences, about 700 farms in Scotland, and 795 in Northern Ireland. By 1996 over 4,000 farms in England and Wales had licences, around 800 in Scotland, and 1,650 in Northern Ireland.

**Embryo transfer services and their regulation**

5.34 Embryo transfer began in the UK on a significant scale in 1972. By the mid- to late 1980s it was estimated that there were 10,000 embryo transfers per year in Great Britain. There was no regulation of embryo transfer in the UK until 1993, when the Bovine Embryo Collection and Transfer Regulations were made to implement the requirements of EC Directive 89/556/EEC. The Regulations required the official approval of teams collecting bovine embryos and regulated the...
transfer of embryos into recipients; they also included provisions to protect the welfare of donor and recipient animals.

5.35 The 1993 Regulations were replaced in October 1995, when the Bovine Embryo (Collection, Production and Transfer) Regulations 1995 came into force. The 1995 Regulations were similar to the 1993 Regulations but extended their scope in several respects, for example, to include all embryos. By 1996, there were 25 teams approved in Great Britain for both the collection and transfer of bovine embryos, all but one of which were approved for intra-Community trade as well.

Embryo transfer and BSE

5.36 In 1992 the EU implemented new controls in response to the BSE problem in the UK. Commission Decision 92/290/EEC required that any donor females used in the embryo trade from the UK had to be BSE-free, born after 18 July 1988, and the offspring of a cow unaffected by BSE.

Meat and Livestock Commission breeding services

5.37 The main objective of MLC beef breeding services throughout the 1980s was the ‘progressive improvement in the genetic potential of commercial cattle to produce high quality beef economically’. The core service was the Pedigree Recording Scheme, used by the majority of breeders rearing bulls for service. The MLC also operated ‘performance testing stations’ for beef bulls up until 1986, where bulls owned by various farmers could be sent at the age of about six months. After 1986 testing was carried out on farm under MLC beef specialist supervision.

5.38 The MLC continued to play an active role in the development of breeding technology through the 1990s via its research and development programmes. A priority was the ‘development and implementation of breeding programmes based upon technologies such as Best Linear Unbiased Prediction (BLUP) and Marker Assisted Selection (MAS) cross-linked to bovine gene maps.’ The MLC saw itself as an important facilitator of improved breeding, using its programme of research to deliver new techniques to the industry.

Milk Marketing Board breeding services

5.39 In addition to providing AI services, Milk Marketing Boards in Great Britain and DANI provided breeding programmes for farmers, with the main object of herd improvement. The basis of the programmes was effective progeny-testing. These testing programmes were also used to assess the breeding qualities of beef bulls, mainly for use in dairy herds to produce crossbreed calves for rearing as beef animals.
Relevant aspects of pregnancy and calving

5.40 The gestation period of a cow is approximately nine months. Pregnancy may not go to its full term for a number of reasons. It is estimated that about 8 per cent of fertilised ova fail to develop because of some genetic defect or incompatibility between sperm and ovum. Foetal death between 25 and 30 days of pregnancy is common, and in most cases the foetus is absorbed into the uterine tissues.\(^\text{99}\)

5.41 Abortion of the foetus also occurs. Brucellosis used to be the main cause of abortion in cattle. Since its eradication in 1985, abortions have accounted for only about 2 per cent of all calvings.\(^\text{100}\)

5.42 After calving, cows normally expel the afterbirth in a single piece within six hours. In a minority of cases, detachment can take up to seven days.\(^\text{101}\)

5.43 If left to its own devices, it is common for the cow to eat its own afterbirth.\(^\text{102}\) Before the advent of BSE, an afterbirth was sometimes ‘put out with the muck’ and treated as compostable material, or left in the field, giving badgers and foxes access to it. A cow will not eat afterbirth that is not its own.\(^\text{103}\)

5.44 In response to the BSE epidemic, MAFF provided health and safety advice to farmers on precautions to take when assisting with calving. This included guidance on minimising the risk of transmission of BSE from cow to farmer via the placenta (see vol. 6: Human Health, 1989–96).

---

\(^\text{99}\) J Webster, Understanding the Dairy Cow, p. 316
\(^\text{100}\) J Webster, Understanding the Dairy Cow, p. 317
\(^\text{101}\) J Webster, Understanding the Dairy Cow, p. 314
\(^\text{102}\) J Webster, Understanding the Dairy Cow, p. 77
\(^\text{103}\) T2 p. 46