Dairy/Milking Shorthorn: conservation of an endangered heritage breed of cattle

Alderson, G. L. H.

Rare Breeds International, Christchurch, UK

ecnewal@gmail.com

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Summary

The Dairy Shorthorn breed of cattle has been registered in Coates's Herd Book since 1822. It is native to northern England and was dominant in its country of origin, with significant international influence, until the mid-twentieth century. Its subsequent decline due to breed substitution and breed society policy caused it to become critically endangered. The factors and strategy underlying its survival and recent recovery provide indicators for the conservation of critically endangered breeds, especially those with high priority due to their special heritage classification. An initial study in 2011/12 defined the numerical status and geographical distribution of the breed by analysing information from national NGOs and DAD-IS/EFABIS data. The current study accessed the same sources in order to evaluate the success of the conservation policy applied during a period of five years and identify obstacles that potentially could prevent further recovery of the breed.

Introduction

All Shorthorn cattle are derived from the same foundation population in the Tees valley in North-East England but dual-purpose Dairy Shorthorn and Northern Dairy Shorthorn (NDS), and beef Whitebred and Beef Shorthorn, emerged as separate breeds through subsequent divergent development. Initially they all were registered in Coates's Herd Book.

In 1949 more than half the bulls registered in Britain were Dairy Shorthorn, and in that year there were 55,000 new registrations in the herd book. Thereafter the breed declined rapidly in the face of competition from Friesian cattle. By 1960 it had become a minority breed when only 10% of licensed bulls were Dairy Shorthorn. The precise status of purebred animals thereafter was obscured by the inclusion of other breeds and crosses in Coates's Herd Book following a decision taken in 1969 by the Shorthorn Society of United Kingdom and Ireland (SSUKI). Fifty years later it was a critically endangered breed. "In 2012 there were 50 breeding cows and only 6 purebred Dairy Shorthorn calves were registered" (Porter et al, 2016) in its country of origin.

From time to time Coates's Herd Book has provided registration facilities for other Shorthorn breeds such as Beef Shorthorn and NDS. It was mismanagement of NDS registrations which initially triggered critical investigation of Coates's Herd Book. The author took action to save some NDS cattle during the major FMD outbreak in UK in 2001 and later, with Castle and other interested parties, published a separate Register for NDS cattle, conducted a programme of DNA testing, calculated GCI (founder effect) and prepared breeding programmes. This work alerted Castle to the plight of purebred Dairy Shorthorn cattle in Coates's Herd Book and he undertook and funded a private programme of embryo transfer to increase the number of breeding females.

Although the constitution of SSUKI defines its primary objective as protection of the purity of Dairy Shorthorn cattle, it refused to support efforts to conserve purebred animals and obstructed initiatives by the author, Castle and others. Its priority was promotion of Blended Red-and-White (crossbred) cattle. In 1969 it "took a decision to introduce a programme of crossbreeding. A trial began the following year with the introduction of genetics from several other breeds including Red Holstein, Red Friesian, Danish Red, Meuse-Rhine-Yssel and Simmental" (Porter et al, 2016).

The Dairy Shorthorn had been exported to many other countries and SSUKI exerted a strong influence on the various national breed societies to adopt the crossbreeding policy. Action to counteract this

process was taken through European Union (EU) regulations by Irish breeders in 2004 to challenge the policies applied by SSUKI, but change was avoided until 2008 before which time SSUKI had reinforced its crossbreeding policy further in 2006 by permitting admission to the herd book to crosses with British Friesian, Holstein, Red Dane, M.R.I., Swedish Red, Norwegian, Ayrshire, Angler and "*other breeds may be considered on application to Council*" (SSUKI, 2006). "*The policy of cross-breeding was continued and reinforced by a Society decision in 2006 with the result that the Dairy Shorthorn ancestry has been diluted in some cases to a negligible level. Despite this the resulting population is registered in Coates's Herd Book and is described as Dairy Shorthorn*" (Porter et al, 2016). The enforced revisions to the registration procedure were published in August 2008 (SSUKI, 2008) but the continuing policy of SSUKI was confirmed by its Secretary (F Milnes) in a message on 15 July 2011 which stated "- - *our Society has no interest in trying to identify original populations of Dairy Shorthorns*."

At that point Rare Breeds International (RBI) took action to protect the remaining population of purebred Dairy Shorthorn cattle and launched the Dairy Shorthorn Project. The first phase of the project was conducted in 2011 and an interim report produced in 2012. The current survey and report was undertaken in 2017 to review progress after a five-year interval.

Material and Methods

Information was obtained from the same sources used for Phase One of the Project in 2011. The purpose of Phase Two was to update the results and note any new initiatives to conserve purebred Dairy Shorthorn animals and evaluate their effectiveness.

Initially reference was made to FAO (DAD-IS and EFABIS) (Table I) but analysis of the information indicated it was not compatible with other survey data. It should be noted that in USA, Canada and New Zealand the breed is called Milking Shorthorn.

Table I: DAD-IS data for Dairy/Milking Shorthorn
number of animals in each national population

Country	Total	Males	Females	Notes
UK	9009			See UK section below
USA	2795			
Australia	294			
South Africa	1082			
Canada	3524			See Canada section below
Sri Lanka	4000			See Sri Lanka section below
Peru	51	13	38	See Peru section below

Further information was sourced from RBI Directors in relevant countries, officers of national NGOs and national societies for the breed, in order to corroborate the FAO data. National reports provided conflicting evidence and necessitated further verification which rendered the data in Table I unreliable. Particular discrepancies related to the results from UK, Canada, Sri Lanka and Peru. They are analysed in greater detail below in the country reports. The underlying problem in the DAD-IS data was failure to define the exact type of animals included in a survey. In a message to Cardellino the author stated: "Your summary of survey procedure provides good reasons why conclusions must be reached with careful interpretation. In the case of the Shorthorn not only are there different strains and types within the breed group, but also national variations in the definition of purity. The problems also extend to comparative breed trials where the results may vary significantly depending on sampling procedure. It is important that research workers define more precisely the animals selected in their sampling procedure. For example, any trial which includes Dairy Shorthorn should identify them as purebred Dairy Shorthorn, Blended R&W, NDS, or other segment of the population." Information from RBI Directors and national NGOs defined the status of the animals included in their results.

Results and Discussion

Country reports have been used to determine the global status of the Dairy Shorthorn breed of cattle. The results are shown in Table II. In some countries the numerical status was expressed as the number of breeding cows. Other countries used the number of annual registrations of female calves. In the latter case the number of active breeding cows was estimated by using a conversion (derived from breed survey data carried out by the author 1994-2007 in UK) where each new female registration is equal to four breeding cows.

Table II: Results of survey of national populations 2017

Information on herds, breeding animals, registrations and genetic material in cryogenic stores

Country	Herds	Cows	Bulls	Reg. all	Reg. M	Reg. F	Semen	Embryos	Notes
UK	5	342	33				yes	yes	Plus 4 small herds
USA		632		186	28	158	yes	yes	3-yr rolling average
Australia		340		101	24	77	yes		3-yr rolling average
South Africa	1								
Canada									No reliable information
Eire									No reliable information
Brazil							yes		
NZ		3841							Status not verified

Definition of 'purebred', and the procedure for verification of purity, was an initial difficulty as the definition varied between national populations. Information obtained in Phase One of the Project showed variation in these procedures and it was proposed two groups should be recognised, namely animals which are 100% and other animals which are 94% or more pure and thus recognised as purebred if a 4-generation grading-up process is accepted. Both groups are included in Table II.

The common ancestry of the four Shorthorn breeds can present problems of interpretation and definition when, for example, an animal which is essentially beef type still can trace its pedigree to Coates's Herd Book. It is important that research workers record define precisely the type of animals (i.e. the segment of the Shorthorn population) and their level of purity in the conduct and publication of any study.

Country reports

United Kingdom. It proved difficult to obtain reliable analyses of the Dairy Shorthorn population in the United Kingdom (UK) because the breed society (SSUKI) has pursued a policy to support and develop a crossbreeding programme for Blended Red-and-White cattle since 1969. The issues were described and brought to the attention of Defra by RBI in a letter of 18 January 2012 as follows:

"The Dairy Shorthorn, also known as the Milking Shorthorn in some countries, is a native UK breed of great historical importance. It has been registered since 1822 in Coates's Herd Book, which now is administered by the Shorthorn Society of United Kingdom & Ireland (SSUKI). The primary object of SSUKI, as stated in its Constitution, is to *"maintain unimpaired the purity"* of Shorthorn cattle. Contrary to this object, SSUKI initiated a crossbreeding programme in 1969 with the purpose of developing a new hybrid breed of cattle known as Blended Red-and-White. The policy of crossbreeding was confirmed and reinforced by a statement in 2006, and the resources of SSUKI continue to be devoted primarily to animals that are not pure Dairy Shorthorn (e.g. Blended Red-and-White and 'Red Genetics'). As a result the pure Dairy Shorthorn now is classified by RBI as an endangered breed.

An application to EU by the Irish Shorthorn Society, and subsequent correspondence between SSUKI and Defra in 2004, confirmed that SSUKI had contravened EU zootechnical regulations (Decision 84/419/EEC) and that Defra (and MAFF previously) had neither monitored nor prevented this illegal conduct. The exchanges resulted in stronger requirements for SSUKI to accept and apply EU zootechnical regulations and included a requirement to give each animal an actual % purity figure. Coates's Herd Book regulations were revised eventually with effect from 1 January 2008 but large loopholes remain and the Dairy Shorthorn continues to become more critically endangered. In this context, RBI launched an international project to assess the status of the breed with partners in UK, France, USA, Canada, Australia and South Africa. The first phase of the project has confirmed the national and international endangerment of purebred Dairy/Milking Shorthorn cattle. This situation embodies loss of native AnGR through the increasing threat to a native breed with heritage value. It raises questions regarding adherence to the Convention on Biological Diversity (CBD) (Article 6: "*Develop national strategies, plans or programmes for - - biological diversity*", and Article 8: "- - *regulatory provisions for the protection of threatened species and populations*") and the UK National Action Plan on FAnGR ("*Each country is particularly responsible under the CBD for the genetic resources in its native breeds*"). RBI requests Defra to investigate and remedy the situation.
Inspection of the SSUKI website (www.shorthorn.co.uk), which is presented under the title 'Red Cattle Genetics', reveals several unsatisfactory records which make published % figures unreliable and allow animals to fast-track to 'pure' status. For example, the pedigree of Pecketsford Pargetter (028698133) shows his status as 81.875%, yet the average of his great-grandparents is only 68.75%, and includes one animal shown as 40%, which is the progeny of two animals which are 0.00%. Therefore RBI requests Defra to require SSUKI to publish records on its website traceable to 1969 and to provide verifiable % calculations for each individual. 93 bulls were registered in 2011. These included 12 Scandinavian Red bulls (a different breed), 1 Appendix bull (13.672% Dairy Shorthorn) and 5 NDS bulls, which together comprise 19.4% of the total. The remaining 75 bulls are shown as either 'Pure' (24 Bulls; 25.8%) or 'Supplementary' (51 bulls; 54.8%). It is unacceptable, in view of the primary object of SSUKI, that only one-quarter of the bulls should be 'Pure'. However, scrutiny of the pedigree of each of these 'Pure' bulls reveals an even more threatening situation, and they are open to question as they contain one or more of the following:

1) Most of the 'pure' bulls result from grading-up through the male line, a procedure that was not permitted under Regulation 84/419/EEC. A letter in 2004 from Bernard Van Goethem (EU Directorate E) states "*This kind of upgrading is not foreseen for the male side because of the very significant changes to a breed that can be brought about very quickly because of the reproductive capacity of the male (e.g. artificial insemination)*". As a result of political pressure, the procedure was amended by 2007/371/EC which allows bulls to be entered in the Supplementary Register but *"their genes should be infused into the main section through their female progeny only*" (clause 7) as had been advised in a letter of 26 June 2007 from Paul Hogan (Defra). However, even this concession was not observed as Milkhill Strider was 90.63% but shown as 93.75%.
2) One bull has a sire, Townview Eddie, which is only 90.625% Dairy Shorthorn. Not only does this show grading-up to 'Pure' through the male line, but also the use of a bull with less than 93.75% rating.
3) In some cases beef bulls, such as Aughmashannagh Edgar, have been used in the sire or grandsire generation but the Beef Shorthorn is recognised by Defra as a separate breed.
4) There is significant introgression from other breeds (RF, MRI, SSR, RED) and particularly USA or Canadian genetics with documented introgression. The USA herd book has been opened to substantial introduction of outside blood, first from Illawarra and then Red-and-White Holstein, and animals registered as Milking Shorthorn have significant Holstein introgression. Pedigree details are available from American data.

In view of the discrepancies illustrated by these examples, RBI wishes to present the following questions, and would be grateful for explanations in the context of CBD, FAO policy on local breeds, EU zootechnical legislation, UK National Action Plan and Coates's Herd Book objects:

1) Is SSUKI observing and implementing rules and regulations required by EU and Defra? Relevant items include the use of bulls <93.75%, lack of validation of % figures, and use of beef bulls. The statement by SSUKI in 2008 (Supporting Document 2) ("Animals over 92.75% will not now be upgraded to 100%. They will retain the actual calculated percentage figure but will be designated 'pure' Shorthorn") indicates that until 31 December 2007

animals >92.75% were upgraded automatically to 100%. Further, SSUKI does not publish details going back to the start of crossbreeding in 1969, so that even revised % figures are not reliable.

2) What is Defra's policy regarding observing and applying requirements of CBD to protect native breeds? CBD requires signatories to protect native AnGR (Articles 6 and 8 – see above) and to undertake biological impact studies before introducing exotic breeds. Similarly, does Defra endorse the policy of FAO for the protection of local breeds?
3) Is SSUKI observing and applying its primary object (to maintain unimpaired the purity of Shorthorn cattle)? The importance of purebreeding is stated in a letter in 2004 from Bernard Van Goethem (EU Directorate E): "*The idea and principle behind allowing for a supplementary section in a herd book is maintaining purebreeding*".

The evidence available at this point indicates that SSUKI has failed to fulfil its legal responsibilities regarding the Dairy Shorthorn breed of cattle and, even where it may have fulfilled its legal responsibilities within EU zootechnical regulations, it has failed in many cases to protect the purity of the breed as required by its primary object. RBI requests Defra to investigate these issues and, under Decision 84/247/EEC, review the status of SSUKI and, if appropriate, withdraw official recognition from SSUKI as a breeding organisation and suspend its authority until it has adopted and implemented procedures to comply with the above requirements, and has removed all measures which fail to give pure Dairy Shorthorn cattle clear priority for the resources of SSUKI."

Earlier evidence from British Cattle Movement Service (BCMS) records, which included Blended Red-and-White animals, had shown a decline from 4589 animals in 2001 to 3168 in 2007. The number of purebred Dairy Shorthorn cows in 2007 was estimated variously between 150 and 300 cows.

No action was taken by Defra to rectify the situation, and it also was complicit in the provision of incorrect information for the DAD-IS website (Table I). The population given does not describe the status of Dairy Shorthorn cattle in the UK. The figure of 9009 animals was based on data submitted by the UK National Co-ordinator with information from the Defra FAnGR Committee and/or SSUKI which classifies Blended Red-and-White cattle as Dairy Shorthorn. Notes on the DAD-IS website record that significant introgression by Blended Red-and-White (mainly R&W Holstein) had taken place. In a contemporary EFABIS document the population of OP Dairy Shorthorn (OP = purebred) cows in 2012 is shown as 53. The discrepancy between 9009 and 53 renders both figures invalid. The RBI survey in 2011 recorded 11 herds containing a total 147 breeding cows, being 97 purebred and 50 others of more than 94% purity.

The most reliable source of information is Charles Castle who privately organised and funded an embryo transfer programme and spearheaded the effort to save the breed in UK. He reported there were five important herds with four smaller units in 2017. They comprised circa 600 females, of which 342 were breeding cows, but the relative proportions of purebred (100%) and 94-100% animals is not known until full pedigree analyses have been completed to define the absence or presence of two bulls, Meadowhaven Prides Star (Illawarra) and Merriville Peerless (25% Illawarra). There also are 33 purebred (100%) bulls, being five live bulls, four AI bulls and a further 24 bulls with very small stocks of semen. TB restrictions are threatening some herds, but a TB isolation unit has been established and a breeders' group has set out a positive development plan to encourage more breeders to milk purebred cows and to conserve genetic diversity including the collection of semen and embryos (Castle, 2017).

Castle also advised that as from 1st January 2018 Coates's Herd Book was closed (i.e. the crossbreeding programme terminated) which may be a belated result of interventions by RBI and Irish breeders, but at the same time the requirement to show percentage purity of each animal (required as a result of those interventions) will no longer be observed. The immediate and ongoing effect is that crossbred animals will continue to be shown as Dairy Shorthorn. The long-term outcome is uncertain and will need to be reviewed from time to time. The recent retirement of the Secretary of SSUKI may enable more positive support for purebred Dairy Shorthorn animals but is likely to lead to greater uncertainty in the short-term.

The current revival of the Dairy Shorthorn in its country of origin stems from efforts by individuals, supported by RBI, to remedy the damage caused by dereliction of responsibility by the breed society

since 1969. Governmental agencies must also carry some responsibility for their failure to ensure that the breed society followed correct procedures.

USA. The records of American Milking Shorthorn Society (AMSS) registrations in 2016 indicate a relatively stable situation since the 2011 survey, although the number of registrations was lower in the intervening years. The annual results (year, total registrations, male, female) supplied by Martin are: 2012 230 (18/212), 2013 169 (22/147), 2014 154 (33/121), 2015 158 (n/a), 2016 245 (23/222). A three-year rolling average of female registrations converts to a population of 632 breeding cows. There also is frozen semen from 30-40 bulls that would similarly qualify. AMSS applies a strict standard for eligibility as purebred in order to enter the 'Native' (100% purebred) category.

The USA herd is the largest national population in the breed with 48% of the global population of breeding cows. It also is subject to the strictest interpretation of purity whereby animals in the 'Native' category much trace exclusively to the first four volumes of Coates's Herdbook. Sponenberg advised that breeders of Native Milking Shorthorns are becoming more actively organised and this may lead to an increase in the number of animals classified as purebred. It is a major factor in determining whether the global population is viable, and whether global exchange of genetic material is possible. The global population of 1314 breeding cows contains adequate genetic diversity, especially as there is a significant resource of stored semen in addition to bulls for natural service, but reciprocity presents a more serious problem. If a standard of 100% ancestry in Coates's Herdbook is adopted, the global population of eligible cows would fall to approximately 1000 animals, but to less than 50 cows if the AMSS 'Native' categorisation is applied.

Cardellino drew attention to a USDA report on Milking Shorthorn cattle from the National Animal Germplasm Program (NAGP) dated 11 July 2017 which showed 2794 doses of semen stored from 72 donors. It also gave the breed performance averages for 2016 as 6803 kg lactation yield with 227 kg fat and 211 kg protein, but noted there had been significant introgression from Illawarra, Red Holstein and Norwegian Red. These figures have been disregarded as they do not apply specifically to Native (purebred) Milking Shorthorn cattle.

Australia. In 2009 there were approximately 300 milk-recorded Dairy Shorthorn cows in Australia, but the purebred status was not defined and there was no record of animals which were not milk recorded. Close cooperation between RBI, Rare Breeds Trust Australia and the breed society enabled Chambers to obtain information from Doggett, McInnerney and Sim. The number of annual registrations included all those of both sexes in classes A (purebred), B, C and D (50% Dairy Shorthorn). The 3-year rolling average 2014-2016 shows annual registrations of 104 females, of which 85 were classes A and B. Lack of historic electronic recording hinders research of pedigrees, but the results convert to a population of 340 breeding cows.

Recent breed society newsletters report both dispersal of herds and increasing interest in the breed, and advise that the World Conference will be held in Australia in 2019. There has been some influence from the American Milking Shorthorn. Some breeders have stored semen from traditional (i.e. no recorded crossbreeding) bulls, but the semen is not licensed and therefore its use is restricted. Semen has been imported from two purebred Tregear bulls bred in UK.

New Zealand. The Jersey breed office administers all dairy breeds in New Zealand and Goodwin (General Manager) advised 3841 registered Milking Shorthorn cows completed Herd Testing in 2016. An annual conference with 20-30 members is held, and a Herd Book, Production Register and magazine are published each year. However, Willis advised there is no current definition of a purebred Milking Shorthorn, and there has been introgression from Australian Shorthorns. Further analysis and evaluation is required before there can be confidence in the level of purity in the population.

South Africa. In 2011 Ramsay reported there were three herds in South Africa but only one remained in 2017 with no record of the purity status of the animals. There has been introgression in the last decade, mainly Danish Red and Swedish Red. Ramsay also has access to old herd books for the Dairy Shorthorn in South Africa but the accuracy of recent records may not be reliable.

Canada. The Wikipedia website showed a photograph of Dairy/Milking Shorthorn cattle purportedly on Prince Edward Island, but it has not been possible at this stage to verify the provenance of these cattle. The Canadian Milking Shorthorn Society admitted that the section of its herd book for purebred animals ('Closed Herdbook') contained animals from outside sources. In 2002 there were 294 registrations in total, including only 54 Closed Herdbook registrations and administration of the breed had been passed to Holstein Canada. The most recent information from Heath in 2018 confirmed that introgression had been permitted, and probably encouraged, so that she was unable to locate any purebred animals. Therefore the data shown on the DAD-IS website (Table I) must relate to crossbred animals.

Eire. There was a substantial population of Dairy Shorthorn cattle in Ireland and the action of Irish breeders in 2004 indicated that purebred animals existed at that time. However, in 2011 only four herds with purebred cows were identified. The current emphasis is primarily on Beef Shorthorn and there has been a significant inflow of Holstein genetics to the dairy sector. No verifiable information was received regarding purebred animals in 2017. The demise of the breed has resulted from loss of confidence of Irish breeders in the policy of SSUKI and subsequent crossbreeding and breed substitution.

Peru. The data shown on the DAD-IS website (Table I) relates to animals imported recently in 1985. There were significant importations of dairy cattle in the 1980s and 1990s. A report in 2005 claimed that 80% of dairy cattle in Peru were Holstein and most of the remainder were Brown Swiss. Unless new evidence emerges it must be assumed the Dairy Shorthorn population in Peru no longer exists.

Sri Lanka. DAD-IS (Table 1) records Dairy Short Horn cattle in Sri Lanka but it has not been possible to verify they are Dairy Shorthorn. There is no history of importation to Sri Lanka of Dairy Shorthorn animals.

South America (other than Peru). Delgado sought information on the situation in South America in view of the World Conference held in Uruguay in 2016 although its programme focused primarily on Beef Shorthorn cattle. Cardellino, with further advice from Machado, confirmed there were no recognised Dairy Shorthorn cattle in Uruguay, Argentina and Brazil. However, Machado does hold some stocks of Dairy Shorthorn semen including Newton Wonder which was exhibited in Scotland at the Highland Show in the 1970s. Sponenberg suggested there might be some animals in the hinterland of Uruguay as breeders in USA had made visits there. However, a search for further evidence produced many images from South America but they were Beef Shorthorn type with some milking ability.

Conclusions

The international dominance of the Dairy Shorthorn declined rapidly from the mid-twentieth century as dual-purpose breeds were replaced by specialist breeds. By the end of the century it had become a minority breed and by 2006 was critically endangered. The data on public websites such as DAD-IS gave incorrect information which over-stated population size and geographical distribution of the breed. The population shown for Sri Lanka never existed, and its presence in Peru was brief. The breed suffered breed substitution and introgression in all countries, but apparently has become extinct in Canada, South Africa, South America and Eire. In UK, the breed's country of origin, the actions of the breed society and governmental agencies further undermined its status and viability through tolerance and encouragement of crossbreeding. The situation in New Zealand remains under review. It did not have an entry on DAD-IS (Table I).

The survey of Dairy Shorthorn cattle in 2017 confirmed the continuing critical level of endangerment of the breed based on the number of purebred animals although it appears the rate of decline may have been halted and even reversed in some areas since 2012. If animals with a pedigree which traces 94% or more to Coates's Herdbook are accepted as purebred the population in both UK and USA is increasing and is stable in Australia. Together they total more than 1314 breeding cows. The recovery of the global population has been achieved by positive action in these three countries since the report in 2012. In both USA and Australia there is effective NGO action (The Livestock Conservancy and

Rare Breeds Trust Australia respectively) working in cooperation with an active breed society. The increase in numbers of the Dairy Shorthorn in UK is encouraging especially noting the current ambitious programmes driven primarily by an individual supported by RBI. Success has been achieved despite the negative influence of the breed society and governmental agencies.

The possibility for current actions to develop into a viable and sustainable programme for the breed globally depends on the ability to deal with potential obstacles. The success in both USA and Australia show that close cooperation between breeders, breed societies, NGO and governmental agencies is essential. Although an individual achieved remarkable success in UK, it is not a reliable foundation for long-term development. There also must be sufficient unrelated lines in the breed to minimise loss of genetic diversity. Details of genetic material in cryogenic storage were not included in the report as mostly it is in private ownership and not generally available, but semen and/or embryo stocks have been noted in UK, USA, Australia and Brazil. Genetic exchange between national populations is likely to become increasingly necessary, but differing definitions of 'purebred' may limit opportunities for reciprocity.

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