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Editorial

There is certainly nothing new in saying that inbreeding, the mating of related individuals, has negative consequences in farmed animal populations. Inbreeding leads to loss of genetic variation and most importantly to reductions in performance (i.e. inbreeding depression) particularly in traits related with fitness such as fertility and viability. Reductions in fitness traits can eventually make further progress imposible despite the presence of genetic variance. Even large populations are experiencing large increases in the rates at which inbreeding accumulates. Examples include US and UK Holstein dairy cattle populations where the worldwide use of few elite sires is leading to current rates much higher than those observed in the past and where deteriorations in health and reproductive traits have been observed. Broadening the breeding objectives for livestock species (Simm *et al*., 2001) would alleviate this but still effective methods for controlling inbreeding need to be applied.

There is clearly a common ground regarding the understanding of the consequences of inbreeding in different areas of research. Population, evolutionary and quantitative genetics and animal breeding, and the more recent area of conservation genetics all deal with the problem of inbreeding. However, published work in these areas is somehow disconnected perhaps due to the modern pressure for publishing within certain time limits (Lean, 2004). Quite often, developments in one area are ignored by researchers in other areas. For instance, important developments in the theory of inbreeding have come from quantitative, population and evolutionary genetics but they are not considered in papers published in conservation journals. Similarly, observations on the consequences of inbreeding coming from evolutionary biology and conservation genetics could be very useful when making decisions in animal breeding programmes.

In this issue, Kristensen and Sørensen (2005) make a valuable contribution by integrating knowledge coming from different disciplines on effects of inbreeding. They review and summarize results to date on inbreeding depression and genetic variation coming from evolutionary biology and conservation genetics and integrate them with animal breeding. They conclude that 'inbreeding in animal breeding must be controlled very efficiently to maintain long-term sustainable livestock production in the future'.

Research in animal breeding has led to important developments, some of them published in this journal (e.g. Sonesson *et al.*, 2000), in selection methods to control efficiently the rate of inbreeding without any costs on the genetic gains achieved. In fact these methods result in higher gains at the same inbreeding, or lower inbreeding at the same gain by optimizing how much each selection candidate should contribute to the next generation. This approach is also highly relevant for managing conserved populations where the interest is not in genetic gain but in keeping the increase of inbreeding to a minimum. The similarities in managing inbreeding in these two areas of research were highlighted at a conference held in Edinburgh in November 2002 and co-organized by the British Society of Animal Science (BSAS), the Department for Environment, Food and Rural Affairs (DEFRA), the Rare Breeds Survival Trust (RBST) and the Sheep Trust (Simm *et al*., 2004). There is not a clear distinction between selection and conservation programmes in farmed populations but the main difference is in the relative emphasis given to rates of gain and inbreeding. Thus equivalent methods for managing inbreeding are applicable to both disciplines. The required input in the optimization methods are the genetic relationships between animals (usually calculated from pedigree), estimates of their genetic merit and the desired rate at which inbreeding accumulates. There is still a question as to which is the acceptable rate. It will depend on the traits of interest and the specific effect of inbreeding on these traits. The review of Kristensen and Sørensen (2005) provides some understanding from evolutionary biology but, as they suggest, animal breeding research still needs to be more concerned about measuring and managing fitness related traits.

Genetic evaluations in selection programmes are improving continuously, for instance by including information on molecular markers. These improvements will allow animals to be genetically evaluated more accurately but also will potentially lead to higher inbreeding. There is no reason for not using the tools already developed for managing inbreeding in practical breeding programmes as their efficiency has been theoretically proven and the information necessary for applying them is available. However, further development of the current available software is needed for implementing the methods on a large scale. The software needs to be well documented, user friendly, and directly applicable to the particularities of different farmed species. Mechanisms to readily incorporate new technologies for managing inbreeding (e.g. use of molecular marker information) in both selection and conservation programmes need also to be put in place. Inbreeding accumulates in closed populations and the way in which we manage it today will have implications in the future.

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Beatriz Villanueva
Section Leader, Breeding and Genetics

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