

207. Infographics for management of inbreeding and kinship in small populations

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Abstract

We developed infographics explaining inbreeding and genetic management for breeders, breeding organisations and the general public. Infographics are illustrations combined with text to obtain clear communication and understanding of concepts. The infographics consisted of three parts: (1) what is inbreeding and what are the consequences; (2) how to manage inbreeding for animal breeders and owners; (3) how to manage inbreeding for breeding organizations. The infographics can be downloaded for free and are available in several languages.

Introduction

Genetic diversity is vital for animal populations to respond to selection and adapt to changing environments. Many breeds, however, have become small in number, with the associated risk of loss of genetic diversity and a parallel increase in inbreeding. This implies potential detrimental consequences such as inbreeding depression and expression of genetic defects. Many breeds, especially in Northern Europe, are managed by small holders and hobby breeders. In these cases, their breeding organisations are often run by volunteers without a professional education in animal breeding. Even though other rare breeds, especially in Southern Europe, are kept at professional farms, inbreeding and kinship are concepts that are difficult to fully grasp. Consequently, there is a great need for information for non-professionals and professionals on how to manage genetic diversity, inbreeding and relationships.

Genetic management is riddled with pitfalls and misunderstanding. For example, many breeders do not realise that inbreeding is not heritable and that a ban on breeding with inbred animals is, therefore, unnecessary. At the same time it can be a challenge to explain why breeders should not all go for a superior sire in terms of the breed standard, top production or championships. These superior sires tend to be highly related which is a threat for the breed in the long term. On the other hand, an explanation on the use of the mean kinship (MK) of an animal with all other animals in the breed can be an eye-opener, leading to better management and maintenance of genetic diversity in the long term.

The theory of what inbreeding is and its relation to genetic diversity, the occurrence of genetic defects and inbreeding depression is well developed in population genetics (Falconer and Mackay 1996, Frankham *et al.* 2010, Lynch and Walsh 1998). Moreover, guidelines have been developed on how to manage populations (e.g. FAO 2013). This, however, is a vast body of material directed towards professional researchers and breeders. A comprehensive summary targeted to a broad audience is needed to reach practitioners and policy makers. To do so, we have developed some infographics that explain principles and practices with colourful graphics that are attractive to read.

Development of the infographics

Infographics are visuals (such as illustrations) combined with text to obtain clear communication on complicated matters. The infographics were developed in cooperation with a professional company specialised in visual communication. The aim of infographics is to inspire the viewer and reader to gain new insights and draw practical conclusions. In order to do so, good infographics take into account how the human brain works to distinguish and to group objects guided by their colour and by the background. The general reading direction in Western culture from left to right and top to bottom is important as well for the design of infographics.

The set of infographics were developed in a process that combined the expertise of the population geneticists with the designers of the agency. First, to get the designers acquainted with the problem, explanations such as those used by the population geneticists over the years for training students and breeding organisations were presented and discussed. Next, all relevant information on the topic was analysed and filtered to keep only the essential concepts. Next, initial sketches were made, texts added, discussed and adapted and, finally, the design was elaborated in full colour.

The first set of infographics was produced in Dutch and presented in an on-line series of seminars for an audience of animal breeders, breeding organisations and other people interested in breeding and inbreeding. Next, the infographics were translated into English, in consultation with experts from different countries. Currently versions in other languages are in preparation.

Structure of the infographics

The information was split into three infographics (Figure 1) in order to avoid too dense information to better communicate the most important messages towards three different target groups. The first infographic describes the basics of inbreeding and is targeted to anyone interested in inbreeding. The second infographic is targeted to animal owners and breeders and shows how to deal with inbreeding at the level of individual selection and mating. The third infographic is targeted to breeding organisations and population managers and visualizes how to deal with inbreeding and relationship at the population level.

Infographic 1: basics of inbreeding. The basic rule that an animal receives half of its DNA from the mother and the other half from the father is the starting point of this infographic. The definition of inbreeding is given and the fact that inbreeding leads to more homozygosity and less diversity is illustrated as well. Furthermore, the problem of recessive genetic defects is treated and why inbreeding can lead to their expression explained. Finally, examples of traits affected by inbreeding depression and common genetic defects are illustrated.

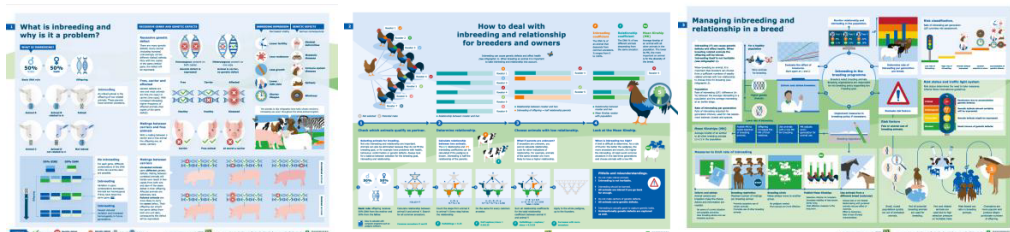


Figure 1. Thumbnails of infographics in English.

Infographic 2: managing inbreeding for breeders and owners. How to choose mates is the main question breeders and owners are faced with, when it comes to managing inbreeding. A flow chart is presented to illustrate the steps to take. It starts with a hen and seven roosters from which its mate can be chosen. Some mates may be unsuitable, because of other reasons besides inbreeding (such as health and breeding goal), and these are discarded in step 1. In step 2 relationship coefficients are determined. At this point, to facilitate the comprehension, the calculation of inbreeding and relationship coefficients is illustrated in the lower part of the infographic. In step 3 mates with a high relationship coefficient (i.e. between close relatives) are discarded. And in the 4th and final step an extra factor is introduced which makes the animal with a low MK to be favoured and chosen. The infographic ends by pointing out four common pitfalls or misunderstandings around inbreeding and providing the correct interpretation.

Infographic 3: managing inbreeding at population level. The information for population managers and breeding organisation is based on the cycle used in animal breeding education (Oldenbroek and De Waay, 2015) with the following steps: (1) Monitor the population by determining average inbreeding and relationship coefficients. (2) Determine the inbreeding rate (ΔF) per generation. (3) Analyse risk factors for the population. (4) Take measures and set up rules to counteract risk factors. (5) Set up communication. (6) Evaluate results. The inbreeding rate is the main indicator tool here, which is illustrated with a traffic light in vibrant colours for each of the categories (Table 1). The term effective population size is avoided because this generally gives a lot of confusion, requiring lengthy explanation to make general public aware of the fact that census size is only one, and often a minor, factor determining effective population size. Instead, risk factors for high inbreeding rates are illustrated. Possible actions to decrease inbreeding rates, such as the use of MKs and a breeding circle, are illustrated as well, with special emphasis on MKs as this is one of the most effective tools.

Discussion

Frequently, there is a rather incomplete understanding of inbreeding. This can lead, on the one hand, to attributing everything that is wrong to inbreeding and, on the other hand, to a denial of any detrimental effect of inbreeding. Consequently, this has led to heated debates and even splitting of breeding organisations of already small populations. The infographics are designed to increase the knowledge of breeders and breeding organisations. The use of social media and other actions may enhance their distribution even further. Evaluation of the effect of infographics on the practices of breeders and breeding organisations will be a next step.

Infographics may be useful for other concepts in animal breeding that are used widely but not always well understood by the general public. Examples can be breeding against diseases or genomic selection. The development of infographics also forces the designers and scientists to evaluate what are the core concepts needed for a proper understanding of the issue, and as such can be a useful exercise for teachers and students as well.

Table 1. Risk assessment based on inbreeding rate.

ΔF per generation	Assessment	Risk	Colour
>1%	Critical	Extinction due to accumulation of genetic defects	Red
0.5-1%	Endangered	Genetic defects almost certainly will be expressed	Orange
0.25-0.5%	Vulnerable	Genetic defects might be expressed	Yellow
<0.25%	Normal	Small chance of genetic defects	Green

Conclusions

The infographics clearly fill in a gap. In the Netherlands, they were readily picked up and links soon appeared after the introduction on websites of several breeding organisations. Three video presentations were made containing elements of the infographics, the first one about the basics of inbreeding has (12/12/2021) over 500 views on YouTube (<https://youtu.be/OSzCsI4UOjs>). This shows the need for this information and that the developed infographics turned out to be really helpful to get the message across.

The infographics can be downloaded from www.fokkenmetverstand.nl (Dutch) and the ERFP website <https://www.animalgeneticresources.net/index.php/publications/> (English). At the time of writing, other languages are in preparation, and links will be made available on the ERFP website.

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