**An Inbreeding Assessment of California Red Sheep**

**H. D. Blackburn and C. S. Welsh**
**National Animal Germplasm Program**
**Agricultural Research Service USDA**
**1111 S. Mason St. Ft. Collins, CO**
**Harvey.Blackburn@ars.usda.gov**

**March 27, 2012**

An evaluation of the California Red sheep was performed to determine the level of inbreeding that has accumulated since the association started maintaining pedigree records. In general, all breeds with closed herd/flock books experience an increase in inbreeding over time. The rate the inbreeding accumulates in a breed is a function of animal numbers, selection intensity, and how well breeders manage inbreeding levels via mating choices.

Inbred individuals are the result of mating parents that share a common ancestor (e.g., a common grand sire or grand dam). The genetic makeup of an individual tends to be more homozyogous than non-inbred individuals. While increased inbreeding tends to make individuals within a subpopulation more similar in performance and appearance it can also increase the frequency of mutant or lethal recessive genes. In fact, intentional inbreeding of mating sons to mothers or brothers to sisters is a common strategy livestock breeders' have used to determine if a bull or ram carries an undesirable allele. The livestock sector has developed and used inbred lines at various points in time. If it is the intention to develop inbred populations this can be achieved with close management by the breeder. However, in general unplanned inbreeding levels can result in depressed performance. In general performance decreases are not particularly noticeable until inbreeding levels exceed 0.20 to 0.25.

**Data**

The association's pedigree file contained 2032 animals. Of these animals there were 215 unique sires and 847 unique dams. The pedigree records were used as input to the program Animal Breeder's Tool Kit to estimate the genetic relationship between animals and compute inbreeding levels for each animal in the file. The results were summarized and put in the following figures.

**Results**

Figure 1 reports the number of animals registered by birth years. In 2004 and 2005 registrations peaked and then entered a period of substantial decrease. Registrations for 2011 are not complete, so it is anticipated that 2011 registration may be similar to 2010.

Figure 2 illustrates the number of registered animals by birth year that had some level of inbreeding. The first year where 100% of all registrations were inbred was in 1997. This level of inbred individual did bounce some in subsequent years but by 2004 and continuing forward all sheep being registered were inbred.

Figure 3 gives the average inbreeding level for animals born in a specific year. Clearly as time has progressed the average inbreeding level has increased. During the last four years average inbreeding level per birth year ranged from .12 to .15. The regression line in Figure 3 is provided to illustrate the rate that inbreeding is increasing. It was found that inbreeding was increasing .004 per year. The equation provided can also be used to project future inbreeding levels assuming mating plans continue as in the past. Therefore by 2020 the average inbreeding level will be 0.216. At this level the potential for observing reduced performance due to inbreeding depression increases.

Figure 4 reports the percent of animal born in 2006-2011 with varying categories of inbreeding. Approximately 75% of the population has inbreeding levels ranging from 0.06 to 0.15. It is important to note that under current management conditions the peaks observed in Figure 4 will shift to the right. In-other-words inbreeding will continue to increase.

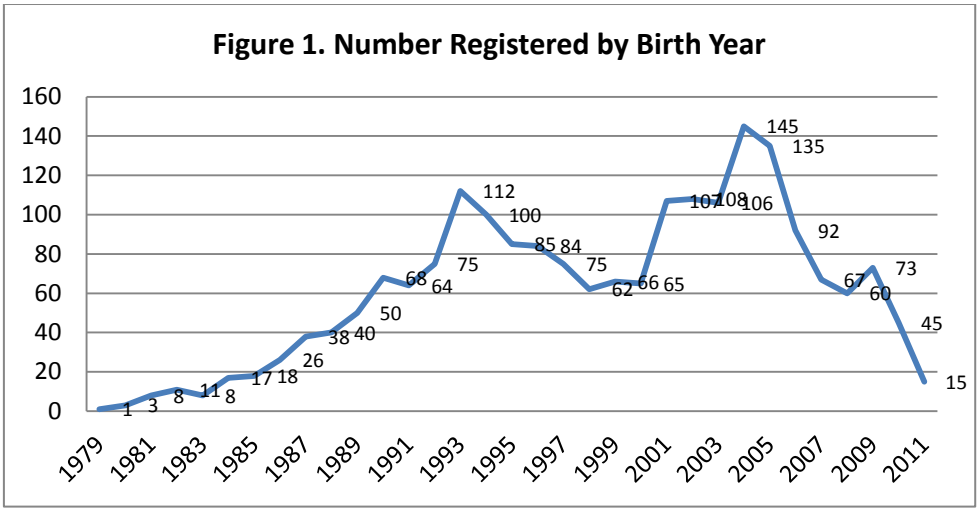
**Conclusions and Recommendations**

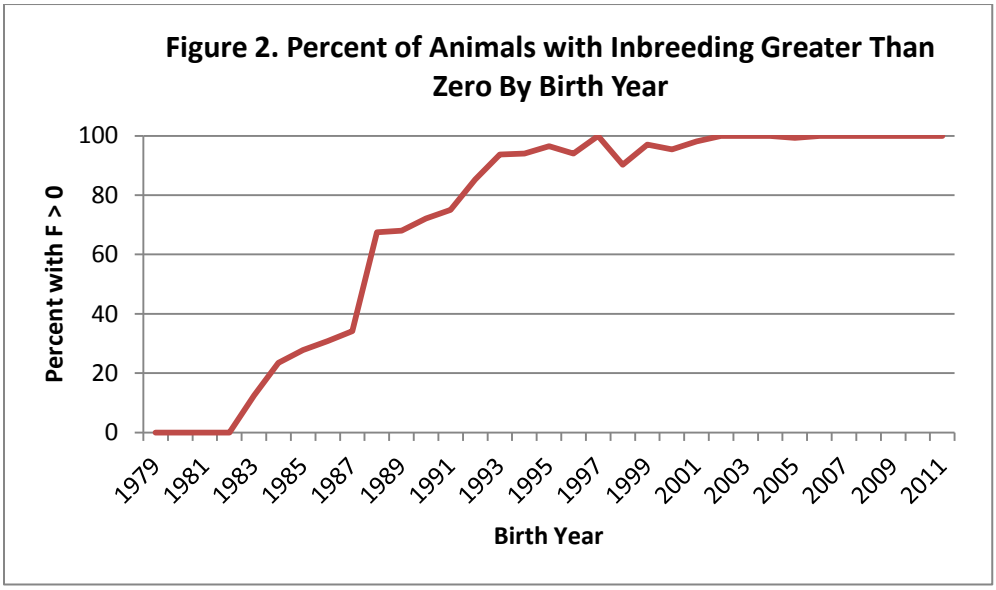
This analysis would suggest that inbreeding is increasing in the California Red sheep breed. The results obtained are typical for small livestock populations. Over the long term with no changes in breed wide mating strategies the observed trend will continue eventually resulting in a substantial decrease in performance due to inbreeding depression. The following are some general recommendations the association may wish to consider.

Due to the existing levels of inbreeding all breeders will need to monitor the genetic relationships between potential sires and dams and inbreeding levels of potential offspring computed before mating. This will allow breeders the opportunity to predetermine how much inbreeding will occur in future generations. However, this process will not stop the accumulation of higher inbreeding levels. As part of such a strategy breeders may want to decrease the ratio of rams:ewes. As this ratio nears 1.0 more genetic diversity will be maintained and inbreeding will proceed at a slow pace. However, this will greatly decrease selection intensity. It has been suggested that ram circles be formed as a tool to slow rates of inbreeding. However, this again is a stop gap measure and requires a substantial number of association members to act in a unified manner, which can be difficult to organize and maintain.

An alternative strategy would be for the California Red Association to re-open its herd book and allow the registration of newly formed California Reds (Tunis x (Tunis X Blackbelly Barbados)). This strategy can drive inbreeding levels back to zero, depending on how widely breeders use the new composite animals. This strategy has been successfully used by a number of cattle breed associations, some with annual registrations of approximately 10,000 head per year. For example, the Brangus association allows a continual influx of newly formed animals into the herd book and they maintain the parentage of the animals as they go through the upgrading process. Not only does this allow inbreeding to be controlled it allows breeders to take advantage of the hybrid vigor generated. California Red breeders could also modify the Brangus approach and allow the formation of new California Reds for a number of years and then reclose its herd books. Either way breeders will how more options in how

they may want to manage the breed's genetics than trying to work within the confines of the existing population.



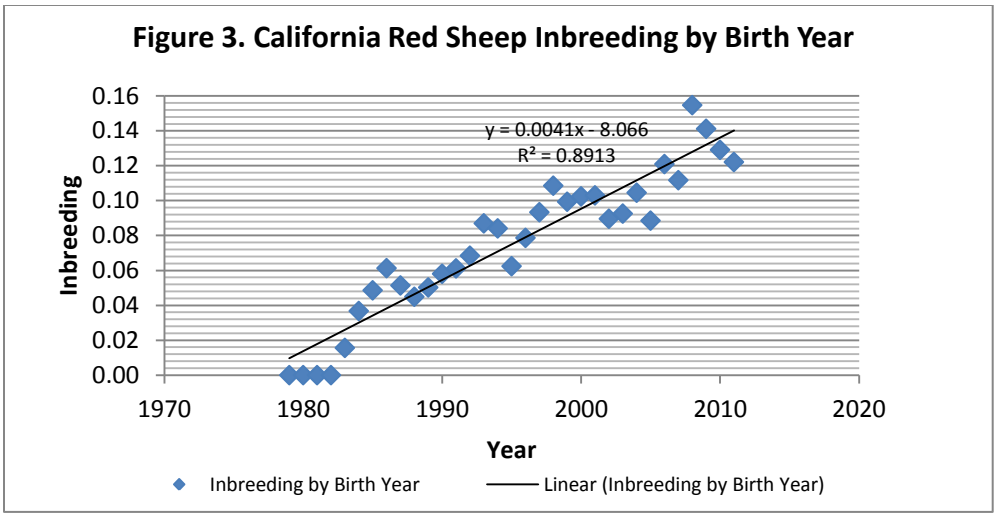


Figure 3. California Red Sheep Inbreeding by Birth Year
y = 0.0041x - 8.066
R² = 0.8913
Inbreeding
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
1970
1980
1990
2000
2010
2020
Year
Inbreeding by Birth Year
Linear (Inbreeding by Birth Year)

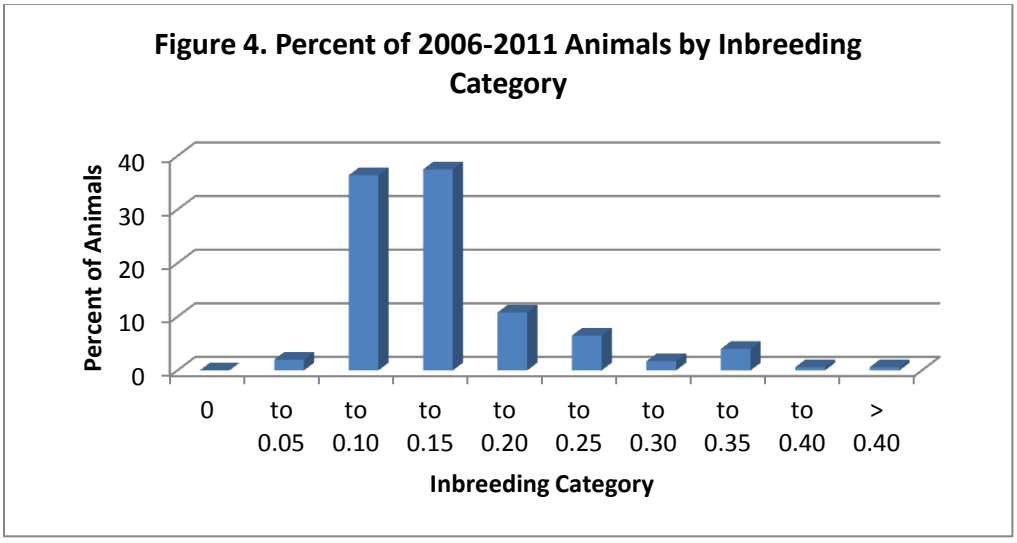


Figure 4. Percent of 2006-2011 Animals by Inbreeding Category
Percent of Animals
40
30
20
10
0
0
to 0.05
to 0.10
to 0.15
to 0.20
to 0.25
to 0.30
to 0.35
to 0.40
> 0.40
Inbreeding Category