Cooperative Extension

The University of Arizona • College of Agriculture •Tucson, Arizona 85721
Gila County Cooperative Extension • P.O. Box 2297 • Payson, Arizona 85547
(520) 474-4160 • FAX: (520) 474-0802 • E-mail sprinkle@ag.arizona.edu

NORTH CENTRAL ARIZONA NEWSLETTER

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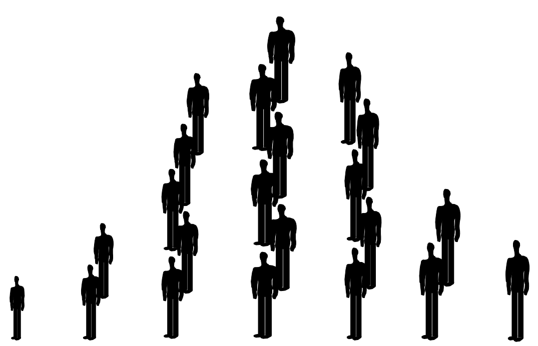
Understanding Statistics

by Jim Sprinkle, Area Extension Agent, Animal Science

In order to properly understand the procedure used to select for many genetic traits in the article "Genetic Selection on the OX Ranch", a statistics primer is presented here. Unlike some readily observable traits (such as hair coat color and presence of horns) which are influenced by only one or a few pairs of genes, most economically important traits are influenced by many pairs of genes. This makes it difficult to predict what will happen when hand mating for a trait such as weaning weight, but we do have some idea of the frequency of certain gene combinations in populations. This is illustrated by Figure 1 which shows the frequency of individuals we would expect for each height classification for adult male soldiers.

In any given "normal" population, most individuals tend to be average. In the above example, most (73%) of the soldiers were from 5' 6" to 6' 0" tall. Height classifications for this sample differed by a standard

Figure 1. Height of Soldiers in Two Squads

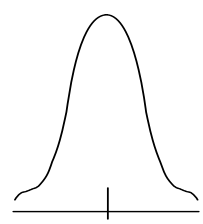


measurement of 3 inches. The difference between the height of the two soldiers in the tallest and shortest categories was 6 X the standard measurement or 18 inches. Only a small percentage of a normal population will be different (plus or minus 2 X standard measurement) from the average or mean of the population. If you were to draw a line over the top of the rows of soldiers above, the line would be in a bell shape.

When we do statistical calculations, we can determine the standard measurement distinguishing categories. This standard measurement for a sample is called standard deviation. The size of the standard deviation depends upon the inherent variability of the sample and adequate sample size.

Figure 2 illustrates a population with small

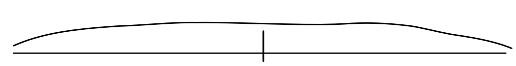
Figure 2. Small Sampling Variability



variation between different classifications. Similar as noted for the soldiers, the height of the curve reflects the number of individuals or items in a descriptive classification. If you were manufacturing "widgits", you would very pleased with the sampling distribution in Figure 2. There would be very little variation between one manufactured widgit and another.

Figure 3 illustrates large variation between different

Figure 3. Large Sampling Variability



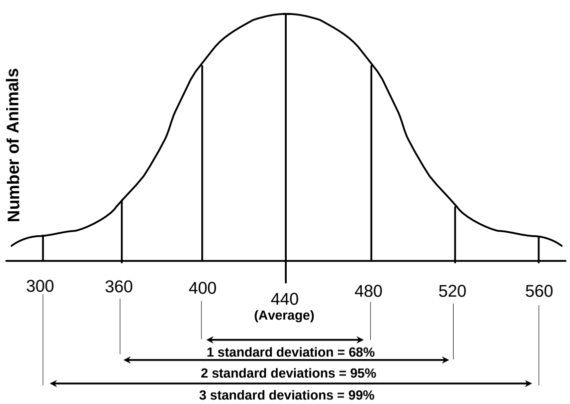
classifications. A manufacturer with this sampling distribution would have problems with quality control of the final product and would need to redesign manufacturing equipment or impose stricter product specifications.

When considering principles of genetic selection, progress in changing the overall average or mean of the herd for a particular trait would be small for populations distributed as either Figure 2 or 3. Progress for the sampling distribution of Figure 2 would be small because of small variation. There would be little opportunity to select outlier cattle greatly different from average. Progress for a cow herd depicted as Figure 3 would be small due to excessive variation. It would be difficult to predict accurately what the overall mean of the herd would be through selection.

Fortunately for us, most animal traits of economic interest are distributed “normally” in a bell curve as noted for the soldiers in Figure 1. This allows us to make predictions in genetic selection. One trait of economic interest is weaning weight. Figure 4 illustrates the bell curve for weaning weight in a herd with 400 weaned calves.

To recap, standard deviation is a statistical

Figure 4. Weaning Weight Bell Curve



Adapted from: Scientific Farm Animal Production, 3rd Ed., Taylor and Bogart, 1988, Macmillan Pub. Co., NY.

measurement that is related to the difference between a measurement (weaning weight for example) and the average of the population (cow herd) you measure. For those who are interested, the process for obtaining standard deviation is as follows. (*Alternately, all spreadsheet programs and many calculators will calculate standard deviation for you.)* For weaning weights, the standard deviation is obtained by: 1) Subtracting the herd average weaning weight from each individual animal weaning weight and squaring each of these answers to obtain positive numbers; 2) Adding all theses squared values up (called sum of squares); 3) dividing the sum of squares by the number of observations (animals) you have minus 1 observation (the result of this division is called variance); 4) Taking the square root of variance to obtain an answer that is expressed in the same units as what you measured (lbs.) instead of squared values (lbs.^{2}). The square root of variance is called the standard deviation. In the example immediately above in Figure 4, the standard deviation was 40 lbs. and the herd average weaning weight was 440 lbs. Standard deviation is a useful measurement to obtain since it allows us to determine how different an individual truly is from the population. In a normally distributed population, 68% of the population will be within 1 standard deviation + or - of the population mean or average. Ninety-five % of the population will be within 2 standard deviations + or - of the population mean. Outlier individuals would be those individuals or animals which could be thought of as greatly different from the rest of the population (herd). These animals are greater than 2 standard deviations + or - from the herd average. Only 5% of the cattle in a normal herd would fit into this category. An example of standard deviations and the normal, bell shaped curve for weaning weights is shown in Figure 4.

In the above example, most animals tended to be average. If you wished to select a future herd bull from your herd that had a weaning weight exceeding the herd average by 90 lbs., you would have about 2 chances in 100 to select such an individual.

One of the standard rules of statistics is that when an observation is more than 2 standard deviations different from the mean, we can say with about 95% confidence that the observation is truly different from the average.

A final thing to remember about standard deviations is that many genetic traits are correlated with other traits which may not be desirable. For example, a bull may have a weaning weight Expected Progeny Difference (EPD) which is 3 standard deviations greater than the herd average while also having a birth weight EPD 2.5 standard deviations greater than the herd average.

Genetic Selection on the OX Ranch

by Jim Sprinkle, John Murphy (owner OX Ranch), and Dick Rice (U of A Livestock Specialist)

As mentioned in the last newsletter, Mr. John Murphy has agreed to share carcass and feedlot performance data from a research project conducted by the OX Little Horse Ranch near Congress. Information gathered from this project will be analyzed statistically by the University of Arizona and genetic selection goals will be established by Mr. Murphy and Mr. Bob Fowler (ranch manager) after consultation with the U of A. The dialogue below is the first installment of an abbreviated version of information shared between the OX Ranch and the University of Arizona.

August 20, 1998
Mr. John Murphy
Phoenix, AZ

Re: OX DNA Breeding Project

Dear Dick and Jim:

Enclosed is a very rough draft of my thoughts as to how to utilize carcass information on making our breeding decisions. I would appreciate very much your input as to the methodology, the actual market values of each quality grade and any information available which we could utilize with respect to the correlation between ADG (average daily gain) and feed conversion.....

John Murphy: *Preliminary Analysis of Carcass Data*

The four principal measures of the value of an animal which has been raised in compliance with quality assurance standards which can be identified are as follows:

1. Quality Grade
2. Yield Grade
3. Dressing Percent
4. Average Daily Gain

I propose that we translate each of these measures into monetary value in order to best evaluate the significance of each. In doing so I propose that we place these measures into the following categories:

A. Those measures that currently affect the Packer's profits but will eventually be passed on to the OX Ranch when Packers begin to pay for carcass value. i.e.

1. Quality
2. Yield Grade
3. Dressing Percent

B. Those measures that currently affect OX profits, i.e., ADG.

Average daily gain represents ADG in the feedlot and has an economic impact as follows:

Interest Cost. The value of a 650 lb. Animal delivered to the feedlot is approximately $480. The cost of money is approximately 10% per annum or $48 per year or $24 for a 180 day feeding period. The interest cost per lb. of gain for an animal with the lowest ADG is almost three times that of the animal with the highest ADG. Each .1 decrease in ADG represents an interest cost of $.70.

Loss of Profits. An animal with an ADG of 3.5 will gain during the 180 day feeding period approximately 18 lbs. more than an animal with an ADG of 3.4. If we assume an average profit per lb. of gain in the feedlot of $.10 then the lost profit for each .1 ADG is $.01 per day x 180 days = $1.80 and the difference in value of an animal with a 1.2 ADG and an animal with an ADG of 3.5 is $41.40. This could be converted from a lost profit to a delayed (though somewhat reduced) profit by keeping the animal on feed for the necessary additional feeding days. But as a practical manner, each group of cattle is sold and slaughtered as a single unit. So, we do lose money on individuals who don't fit the group.

Conversion Rate. There is a correlation between ADG and the rate of conversion of feed to gain. It will be necessary to research this correlation. For the moment, I propose an estimate of $2.00 per .1 ADG.

Based on the foregoing, the total amount to be allocated to each .1 ADG would be:

Interest cost	$ .70
Loss of profit	1.80
Lower conversion rate	2.00
	$4.50

Proposal

I propose that the values determined in the foregoing manner (Editor's note: excluded carcass value estimations from this summary) be refined and that we start with a base value for an animal which assumes that such animal falls in the lowest of the above categories and we add to that base value the values indicated by the foregoing formulas. This should give us a fairly accurate actual market value for each animal and we can make our breeding decisions based on these values.

Very truly yours,
John A. Murphy, Jr.

Sept. 26, 1998
Jim Sprinkle
Payson, AZ

Dear John,

My approach with your data was to first find the standard deviation and mean for each trait of interest and compare this to industry averages. How the animal performs in the feedlot and what kind of carcass it produces is dependent both upon its genotype (genetic makeup) and the environment to which it is exposed. High heritability needs to be combined with adequate genetic variation to make significant changes.

To measure variation, I determined coefficients of variation for each trait to see if it was feasible to attempt to change this trait through animal selection. The coefficient of variation (**CV**) is the amount of variation in a sample and is expressed as a percentage by the equation:

$$CV = (\text{standard deviation}/\text{mean}) \times 100$$

According to Dr. J. W. Turner of Texas A & M University, College Station, you need to have a 10 to 15% CV to make genetic progress. He says that a CV of 30% or greater indicates that the variability is being greatly influenced by environmental conditions which may be beyond your control. How you measure a trait of this type and when you measure may be more important than what you measure. Conversely, a CV of less than 10% is too small to make much progress.

When I discussed analyzing this data and coming up with some type of selection criteria with Dr. Mike Tess of Montana State University (speciality is animal breeding and has been involved in some carcass type genetic research) he made three succinct points. First, in evaluating overall profitability, efficiency in producing a lb. of calf (break-even cost) is equally important to feedlot performance. Secondly, feedlot performance is equally important to the value of the carcass. Finally, it takes a heck of a carcass to get a premium and you can't excel at both quality grade and yield grade (at least for most average cattle).

It appears to me that two opportunities for genetic improvement with your cow herd would be to improve feedlot or post-weaning gain (**PWG**) and to increase marbling. When I tried looking at carcass grid value as an overall measure of profitability, there did not seem to be enough variation to practice selection on this basis (CV was only about 8% for heifers). The CV for both marbling and PWG was about 20%.

Quality Grade or Marbling

For steers, quality grade is less than industry averages (statistical probability of this being due to chance was .01). I used the same numerical scale for marbling as the 1995 Beef Quality Audit: practically devoid = 100, traces = 200, slight = 300, small = 400, modest = 500, moderate = 600, slightly abundant = 700, moderately abundant = 800, and abundant = 900. For steers, your marbling mean of 375 (corresponds to grade of Select+ ; standard deviation of 70) was less than the industry mean of 406 (corresponds to grade of Choice- ; standard deviation of 90). This is undoubtedly affected by less fat cover for steers (.15 for OX steers vs .47 inches for all animals measured in Beef Audit). This may indicate that steers should be fed to at least 1200 to 1250 lbs. and may also indicate that your steers deposit less backfat than industry animals.

When steers were sorted by weight, 17 of the steers that weighed 1200 lbs. or more (18% of the lot) did not grade Choice. This is probably not much different from industry averages. Overall, you had 40% of steer carcasses grade Choice while the industry average is 50% for Choice or better.

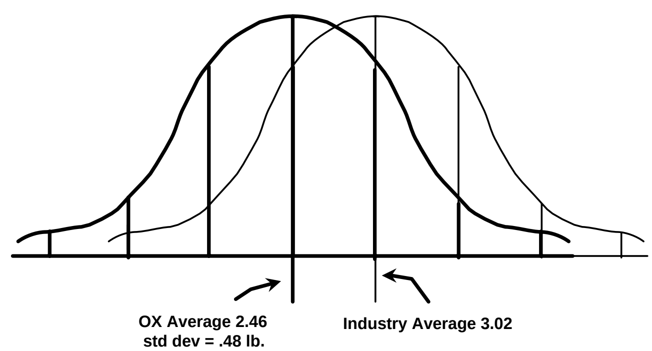
In research done at Texas A & M University, steaks need to have 3 to 7.3% fat within the meat to ensure consumer acceptability. This corresponds to a grade of Select- to Choice+. In the OX data, you had 9% Standard carcasses. It is certain that these carcasses would provide unpleasant eating experiences. The industry average for percentage of Standard carcasses is 3.8%. Again, this is probably influenced by an average carcass weight of 1156 lbs. instead of 1200 to 1250 lbs.

Post-Weaning Gain

This brings me to my next major point. Average daily gain for OX steers is less than industry averages. I compiled a bell curve for OX cattle and superimposed it upon an estimated curve for industry steers (Figure 5). The ADG for industry steers was obtained from the Aug. 17 issue of *Feedstuffs* magazine from data from 25 feedlots in four states. Based upon these figures, about ½ of industry steers perform better in the feedlot than OX steers.

As you so succinctly indicated in your letter,

Figure 5. Steer Average Daily Gain



For the industry, 1/2 of the steers perform better than OX steers

ADG has a big effect upon profitability. It could possibly influence quality grade as well, particularly when comparing low Select and Standard carcasses to Select, Select+, and Choice carcasses. When I separated out the ADG means for these quality grades, they were as follows, Standard (ADG of 2.06), Select- (2.08), Select (2.52), Select+ (2.38), and Choice (2.73). The relationship of ADG to quality grade is probably due to the need for animals to achieve a physiological age (weight) for their respective frame sizes. Until cattle achieve a certain age/maturity, they will not develop intramuscular fat to a great degree. Marbling appears to be both a function of weight and maturity. Slaughter steers put in the feedlot as yearlings almost always have a larger percentage of Choice carcasses as opposed to calf-fed slaughter steers (placed in feedlot as weaners).

Post-Weaning Gain, Feed Efficiency, and Profitability

Table 1. Industry Averages

	Cost of gain/lb. for July 98	Feed efficiency, lbs. feed/lb gain
Steers	.55	6.5:1
Heifers	.59	6.8:1

Cost of gain and feed efficiency (**FE**) industry averages for this section are from the same *Feedstuffs* issue cited previously. Estimates of the influence of ADG upon FE are from a data set I have from research done at Clay Center, Nebraska. For Brahman crosses (50% Brahman), each .1 lb. increase in ADG resulted in about .2 lbs. decrease in lbs. of feed required. So, to increase ADG for steers from 2.5 to 2.8 would result in an improvement in FE of .60 less lbs feed/lb. of gain and going from 2.5 to 3.0 ADG would reduce feed intake by 1.00 lbs. per lb. of gain.

If we estimate that your FE for steers is now 7:1, you could presumably lower FE to 6:4 or 6:1 by increasing ADG to 2.8 or 3.0. If we put the cost of feed at $.06/lb. (doesn't include yardage), then the higher gaining steers will cost $.04 to $.06 less per/lb. gain.

Table 2. 700's Weight Calves Feedlot Performance

	ADG	Feed intake, lbs.	Feed cost/day @ .06/lb.	Value of gain @ .62/lb.	Feed cost/lb. of gain
Steer Type #1	2.5	17.5	$1.05	$1.55	$.42
Steer Type #2	2.8	17.9	$1.07	$1.74	$.38
Steer Type #3	3.0	18.0	$1.08	$1.86	$.36

If all three types of steers were sorted and came into the feedlot at 650 lbs and slaughter weight was 1200 lbs., steer type #1 would take 220 days to reach market weight. This is compared to 196 days for steer type #2 and 183 days for steer type #3. Feed costs, interest, and yardage for the different performing steers are shown below in Table 3.

According to the figures above, the value of each .1 lb. increase in ADG would be on a logarithmic scale with smaller values being returned for each incremental increase. For example, the difference in profitability between 2.5 and 2.8 ADG is $8.79/.1 ADG and the difference between 2.8 and 3.0 ADG is $6.67/.1 ADG.

Sincerely,
Jim Sprinkle

Table 3. Profits for Three Types of Steers

	Feed costs	Yardage @ $.05 per day	Interest	Beg. Cost	Slaug. Value at $.62/lb. for 1200 lb. Choice YG 3	Proj. Profit
Steer Type #1	$231.00	$11.00	$28.93	$480.00	$744.00	— $6.93
Steer Type #2	$210.00	$9.80	$25.76	$480.00	$744.00	$18.44
Steer Type #3	$198.00	$9.15	$24.07	$480.00	$744.00	$32.78

Dick Rice
February 24, 1999
Tucson, Arizona

We are very thankful that Mr. John Murphy is willing to share the information which he is acquiring for his ranch business. The information clearly establishes that cattle producers have large variation within herds for feedlot performance and carcass value. This variation is one of the principal problems for the cattle industry.

Mr. Murphy is making the investment of money and time to evaluate the status of his production and is using advance technology to identify animals with feedlot performance and carcass value. Because of his willingness to share, we plan to use this information to calculate breeding values for carcass value and feedlot performance. To our knowledge, this integration of information has rarely been accomplished. This is truly innovative and progressive work.

The information from the OX Ranch reinforces the need for information of the total production sequence for establishment of important factors necessary for economic progress. Mr. Murphy intends to take this one step further to specify strategies for improvement.

Information derived from the Arizona Ranch to Rail Program confirms the importance of integrating feedlot and carcass information into production goals. Important factors which have been identified include the importance of proper genetics, feedlot health, timely marketing, and carcass value for economic production.

We sincerely appreciate The opportunity to participate with the OX Ranch in this effort and to share information with others.

R. W. Rice

The next North Central Arizona Newsletter will focus on expected progress the OX Ranch could be expected to achieve per year with selection goals. With adequate information, analyzed statistically, predictions can be made for genetic progress and ultimate profitability. The final decisions the OX Ranch made for genetic trait selection will also be presented.