The Next Revolution in Selecting Superior Sheep and its Impact on USA and World Sheep Breeds: Will the Future of Production Agriculture Include Katahdins?

Author's Note: This is a follow-up to the article in the Summer 2008 Katahdin Hairald: "Selecting Superior Meat Sheep in the 21st Century." It is suggested that Katahdins and other sheep breeds that want to remain relevant for meat production need to be proactive and start a strategic planning process. Dr Steven Kappes will speak on "Genomics" and the new DNA technology, the 64K SNP chip at the NSIP Workshop on September 25, prior to the 2008 KHSI Expo and Sale in Maryland.

In the next few months, new DNA technology will be available to the sheep industry. The new technology is powerful and can identify large numbers of DNA markers and genes that affect performance and disease resistance in sheep. The revolution will not be immediate. It will start slowly over the next 5 years, but in 15-30 years will drive sheep production in the world.

The new DNA technology will be combined with EPD selection indices to greatly improve accuracy of selection. EPDs, expected progeny differences, for balanced growth, milk and reproductive efficiency will still be required to a) identify DNA markers and b) to evaluate the performance of sheep with DNA markers.

The key piece of technology is a chip that can assay a single animal's DNA at 64,000 different locations in a short period of time. It is called the 64K SNP chip (Single Nucleotide Polymorphisms; pronounced "snip chip"). Consider being able to identify how the top five rams in your ram pen stack up at 64,000 different genes. The price tag is not that big when we consider being able to assay at 64K positions, but it takes a significant investment. Predictions are that it will cost $500/sheep in 2008.

However, there is a big barrier at the moment. While it will be possible to assay at 64,000 different sites in the sheep genome, we as scientists, producers and breed associations need to learn which of these 64,000 sites in the sheep genome (polymorphisms) affect production traits and which allele of each polymorphism is the preferred one. But that will change in the near future.

Before going on, we need to discuss polymorphism. Those of you who have had a biology, genetics, or agricultural course may remember the term "polymorphism". When comparing the genes between any two individuals of the same species, no matter how much they appear to differ visually, the vast majority of their genes are identical. DNA does differ at several locations and that is what makes individuals and breeds unique and different. The genes that differ in a species are said to be "polymorphic" (poly = many; morphic = form; therefore, more than one form/sequence of the same gene). A common DNA test for a polymorphism in sheep that most know about is for scrapie resistance in the prion gene. Commonly, sheep are RR, QR or QQ and this determines whether sheep have resistance to scrapie and is an example of a polymorphism.

A consortium of sheep scientists from around the world has identified 64,000 sites in the sheep genome in which a polymorphism occurs and used these sites to develop the 64K sheep SNP chip. Next using reference populations of sheep, scientists will correlate performance traits with specific polymorphic markers. Over time, selection of superior rams will include an index of EPDs and multiple gene markers. A breeder will be able to DNA test lambs at birth to know whether they are carrying the traits needed.

What traits will be identified? Multiple markers that affect growth, maternal behaviors, tenderness, taste, feed efficiency, shedding, parasite resistance, disease resistance, fiber traits, aseasonal breeding, prolificacy, body condition and heat tolerance are just a few of the possibilities. Using these markers, over the course of several years seed stock producers will be able to select for a sheep that is highly adapted to specific production system. For example, sheep that are adapted to production in the Southeastern USA on forage alone; or a ewe for the Pacific Northwest that is adapted to wet cool winters and always weans triplets on a diet of only grass forage; or for animals with superior performance on concentrates. In 30 years, we can predict there will be sheep that have DNA markers and EPDs (expected progeny differences) that ensure 10-35% more production on 5-20% less inputs (labor, housing, feed, veterinary care) for a specific environment and management system.

In the last year, a few USA scientists and sheep producers have discussed the impact of the new technology. We have different thoughts about how this technology will affect the USA sheep industry. Some of us think the 64K SNP chip technology will create major changes. Others suggest that the United States Department of Agriculture does not have the funds to do the necessary background research and that without common use of artificial insemination, the USA sheep industry will be less able to capitalize on the new 64K SNP chip technology. Australia, New Zealand and other major sheep producing countries are investing in the research needed to start identifying key performance markers. The USA sheep industry is just starting to talk about it.

It is hard to predict the future of agriculture, let alone make any specific predictions for the sheep industry. Energy and feed prices are at an all time high, which makes it even harder to predict the future of the USA sheep industry, with or without the SNP chip. With planning, Katahdin breeders can take the lead in the USA sheep industry and command their future. It is exciting and daunting at the same time. With good planning, Katahdin breeders can take the Katahdin to new heights.

Possibilities for the future include:

A) Artificial insemination (AI) will become much more common. Without AI, the sheep industry will lag behind the dairy, beef and poultry industries' use of the

CONTINUED ON PAGE 10

64K SNP chip. At $500/animal, the only way for a seedstock producer to recoup the investment of testing his/her ram pen with the SNP Chip will be to sell semen.

B) Proactive and forward looking breeds will have developed strategic plans to use the new DNA technology to complement their current production strengths.

i) There may be only 3-5 of the current sheep breeds in the USA and Canada with significant use in future production agriculture systems. The rest of the breeds will have minor impact on meat production.

ii) Production/environment breeds and types will increase in prominence. New composite types selected for specific management/environments such as feedlots, humid environments or grazing will be developed.

iii) Current breeds that remain important will have made key strategic decisions by a) evaluating their current genetic strengths, b) using the 64K SNP chip to bring in key DNA markers/traits that complement their current genetic strengths, c) embracing AI and d) have an open flock book

C) There will definitely be room for easy care breeds that are disease resistant, have either excellent wool or no wool and require almost no extra labor. These easy care breeds will most likely be selected for specific environments and have integrated newly identified markers/genes for performance, feed efficiency, lamb survival and disease resistance. If energy, hay and grain prices remain high, easy care sheep are even a better investment.

D) Countries that do not invest in the new technology may buy their genetics from the countries that do. If US sheep researchers and industry fail to implement the new technology, the majority of sheep genetics in the USA in 30-40 years could be imported from New Zealand or Australian breeders that have utilized the new technology.

E) The genes and markers involved in shedding will be identified. No-shear sheep will not be limited to a few breeds. Any breed that wants shedding will be able to use the 64K SNP chip to select for shedding while changing few of their other traits.

F) Parts of the sheep industry may become vertically integrated. The increased cost of DNA typing, artificial insemination may require the investments of major companies similar to the poultry and pork industries. This currently hasn't happened in ruminants for multiple reasons, but with increased accuracy of selection and potentially less money from the USDA to put into sheep research, openings for large corporations to provide genetics may occur. (Note: Most scientists consider this to have a low probability of occurrence.)

G) For the record, some in the USA sheep research community predict that USA sheep breeders will not invest in the new technology. As a result, productivity of USA sheep could lag behind as other countries invest in the use of EPDs and the new DNA technologies using the 64K SNP chip.

What does all this mean for the Katahdin breed? With good planning, Katahdin breeders can be in a leading position. Note that in 20-30 years, any "current" performance advantage of the Katahdin will be available to other breeds or be incorporated into specific management types. For example, if the genetics of shedding are simple (less than 3-5 genes) any breed that wants to quit shearing will. Without major improvement, the Katahdin advantage of being more parasite resistant than other major production breeds will disappear. Any breed will be able to incorporate markers for parasite resistance. There is already a patented gene that increases parasite resistance by 10% in New Zealand sheep. Better parasite resistant DNA markers will follow. Those are two examples of how current Katahdin advantages may no longer be unique. But with good planning, Katahdin breeders can build on these two advantages and be several steps ahead.

To remain a key agricultural breed, I suggest that Katahdin breeders need to implement two strategies. In the short term, we need breeders to step forward to take us to new levels of easy care, parasite resistance and meat production. This involves making good use of performance evaluation and EPDs, and will give the breed time to adopt the new DNA technology. Katahdin breeders also need to start developing a strategic plan that will 1) identify where we want the Katahdin to be in 20-30 years, 2) assess which newly identified gene markers are needed and 3) develop group breeding schemes to integrate and potentially fix these new traits into the Katahdin. Care will need to be taken to preserve and enhance the traits that we currently value in the Katahdin.

Future sheep production is an opportunity. Katahdin breeders can stake their position and help lead the sheep industry.

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Sept. 26 & 27, 2008

the KHSI Expo in Maryland