

## Understanding the National Genetic Based Flock Clean-up Plan

### How the Plan Works

- There are three basic steps in the new plan:
  1. When an infected flock has been identified, the sheep are genotyped. The sheep's genotype determines its risk for scrapie infection.
  2. Susceptible genotypes are either removed or their movement restricted.
  3. The flock is placed under surveillance for five years.
- Benefits of the Plan:

In most cases, producers will be able to keep many more of their sheep with a genetics based plan. This plan allows owners to retain or sell without restrictions nearly all sheep that are AA RR, AA QR<sup>4</sup> and most AV QR<sup>5</sup> (Table II) from infected or source flocks once owners have met certain conditions.

It is estimated that, on average, 60 percent of a flock can be preserved when using a genetics based plan compared to 25 percent when using a traditional plan.

### Requirements of the Plan

1. All exposed QQ ewes, exposed female goats, and female offspring of scrapie positive ewes will be removed or will be placed under movement restrictions.
2. AV QR ewes may be required to be removed or restricted in flocks where scrapie positive VV QQ, AV QQ, or AV QR sheep have been identified. Positive animals, with a V at codon 136, in a flock indicate that exposed AV QR ewes from that flock may be susceptible to the type of scrapie that is in the flock.

**How All Producers Benefit** – All producers can benefit from the National Genetic Based Flock Clean-up Plan in several ways. The plan allows resistant breeding stock to be preserved. It protects other flocks from exposure by requiring the removal or permanent restriction of animals that may spread scrapie. It permits affected producers to return to normal business practices more quickly than previous plans. The use of genetically-resistant rams will break the transmission of scrapie in newly exposed flocks, thus reducing the risk of them becoming infected or source flocks. Additionally, it encourages producers to limit their risk of acquiring scrapie by utilizing genetic testing and selection. All of this will help meet the goal of eradicating scrapie in the U.S. by 2010 and have the nation recognized as "Scrapie Free" by 2017.

3. All animals in the flock must be officially identified and entered in USDA's Scrapie National Generic Database by federal and/or state personnel.
4. Owners must have a post-exposure management and monitoring plan that includes:
  - Official identification of sexually intact animals that are sold or acquired and records of such transactions including basic information of the buyer/seller;
  - Reporting of deaths of any mature animals and submission of animals showing possible signs of scrapie for diagnostic testing;
  - Annual inspections by state and/or federal officials;
  - Owners who elect to retain restricted female animals will have to meet additional requirements including testing and restrictions on some offspring.

### Other Aspects of the Plan

Owners whose animals must be removed from the flock will receive indemnification from the federal government based on commercial market prices reported by the Agricultural Marketing Service. An additional premium will be paid for registered animals and may be paid for animals for which the owner can document a higher market value such as some club lamb flocks.

Further, the federal government will provide testing and assistance with disposal costs. The producer is responsible for gathering and handling the sheep, applying identification, providing adequate handling facilities, cleaning and disinfecting, reporting suspect animals, and maintaining records such as sheep sales, purchases and lambing.

## A Final Word

*These recommendations are intended for producers who:*

- Have scrapie in their flock, or
- Have flocks that have been exposed to scrapie, or
- Have breeds that have a high prevalence of scrapie in flocks that are not known to be free, or
- Purchase ewes of unknown status.

*The selection of genetically resistant sheep is a highly effective method of minimizing the risk of scrapie infection; however, maintaining a closed ewe flock is the most effective preventive measure.*

*There is still much to be learned about scrapie genetic susceptibility in sheep and goats, so as research provides further information, the Accelerated Scrapie Eradication Program will be adjusted accordingly.*

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For more information, call toll-free **1-866-873-2824**. This number will put you in touch with animal health officials in the state you are calling from who are responsible for the scrapie eradication program.

The following websites provide additional information on scrapie genetics, genotyping and the National Scrapie Eradication Program:

[www.aphis.usda.gov/vs/naahps/scrapie](http://www.aphis.usda.gov/vs/naahps/scrapie)

[www.animalagriculture.org/scrapie](http://www.animalagriculture.org/scrapie)

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## The ABCs of Genetic Based Flock Clean-up and Monitoring Plans

*There is a new aspect to the national Accelerated Scrapie Eradication Program: Flock clean-up plans based on genetic testing. The new plans apply only to scrapie infected, source, and exposed flocks. However, it is important that all producers are aware of how genetic resistance to scrapie can be used to minimize the risks of acquiring scrapie and eliminate scrapie from a sheep flock if it becomes infected.*

## Genetic Based Flock Clean-Up Plans

There is a new aspect to the national Accelerated Scrapie Eradication Program: Flock clean-up plans based on genetic testing. **The new plans apply only to scrapie infected, source<sup>1</sup>, and exposed flocks.** However, it is important that all producers are aware of how genetic resistance to scrapie can be used to (1) minimize the risks of acquiring scrapie and (2) eliminate scrapie from a sheep flock if it becomes infected.

Due to their genetic make-up (see *The ABCs of Genotyping*) some sheep are more susceptible to scrapie and some are more resistant to the disease. The genes that control susceptibility/resistance can be identified by a blood test<sup>2</sup> known as **genotyping** or DNA testing.

Until now, with the exception of a few states with pilot projects, risk in flocks infected with scrapie was determined primarily by exposure to the disease. This resulted in a large percentage of exposed breeding animals being destroyed, prohibited from movement or sale, or restricted to movement by permit only.

Now, under the National Genetic Based Flock Clean-up Plan individual sheep that are found to be genetically resistant to scrapie through genotyping, and whose owners have met various other conditions, can be moved and/or sold in a normal manner. Details of the plan appear on the reverse side.

**Full implementation of the national Accelerated Scrapie Eradication Program was started in 2001 by the U.S. Department of Agriculture's (USDA) Animal and Plant Health Inspection Service (APHIS) Veterinary Services (VS). It is expected to take up to 10 years to complete the program's goal of eradicating scrapie from the nation's sheep flocks and goat herds.**

## The ABCs of Genotyping

### A. General information about genotyping

- An animal's genotype never changes, so it can be tested at any age.
- Under most circumstances one test during an animal's life is adequate to determine its genotype (susceptibility/resistance to scrapie). In the case of exposed sheep, the new plan currently requires two tests to minimize any chance of error in sampling, labeling, or testing.
- The genotyping test measures only an animal's susceptibility/resistance to scrapie, **not** whether it **has** scrapie. The third eyelid test can be used to detect scrapie infection in some animals.

### B. Basic facts about sheep genetics and how genotyping is used to determine scrapie resistance/susceptibility

- Out of the many sheep genes scientists have identified, one pair affects scrapie susceptibility as well as the disease's incubation time. That gene is known as **PRNP**, which stands for the **PRioN Protein** gene.
- Each sheep has **two copies of the PRNP gene**; one derived from each parent.
- In uninfected sheep the PRNP gene produces the normal cellular prion protein molecule known as **PrP<sup>c</sup>**. In scrapie infected sheep the abnormal prion protein, **PrP<sup>sc</sup>** or **Prions**, is found. Prions are closely associated with scrapie infectivity and are believed to be the causative agent.
- Genes are made up of **codons**. Each codon instructs the body cells to put a specific amino acid at a particular location when building a protein molecule.

- Since PrP<sup>c</sup> is composed of **256 amino acids**, these locations are numbered from **1 to 256**.
- Two codons — **136** and **171** — are particularly important to scrapie susceptibility<sup>3</sup>.
- Codon 171 can give instructions to insert the amino acid **Histidine (H)**, **Glutamine (Q)**, or **Arginine (R)** at position 171 of PrP<sup>c</sup>. The letter in parentheses is the single letter biochemical abbreviation for each amino acid. At codon 171, R is very important because it produces the greatest scrapie resistance.
- Codon 136 can give instructions for either **Alanine (A)** or **Valine (V)** to be amino acid at 136 of PrP<sup>c</sup>. The presence of V (Valine) at 136 makes **AV QR** sheep susceptible to **certain** scrapie strains.
- As previously stated, sheep have two copies of the PRNP gene, one from each parent that can produce **one** of four possible combinations of amino acids at locations 136 and 171 as shown in Table I.

**Table I – Amino Acid Combinations Indicating Susceptibility/Resistance**

	Location	
	Codon 136	Codon 171
Amino Acid	A	R
	A	H*
	A	Q
	V	Q

\*H, or histidine, at codon 171 is considered to have the same susceptibility as Q, glutamine, and is therefore represented as Q in all combinations discussed in this brochure.

### C. Producers need to be familiar with six genotypes and their corresponding amino acid combinations to understand genotyping for scrapie resistance.

When both copies of the PRNP gene are considered, a sheep can have one of six genotypes. Based on what is **now** known, the following genotypes at codons 136 and 171 (shown in Table II) are used to determine the scrapie susceptibility of sheep.

**Table II – Genotype Susceptibility/Resistance Combinations**

1. AA RR – Sheep which are *resistant*.
2. AA QR – Sheep which are *rarely susceptible*.
3. AV QR – Sheep which are *susceptible to some scrapie strains\**.
4. AA QQ – Sheep which are *highly susceptible*.
5. AV QQ – Sheep which are *highly susceptible*.
6. VV QQ – Sheep which are *highly susceptible*.

\*These strains are believed to occur with low frequency in the U.S.

At this time, no resistant genotypes have been identified in goats. All goats, therefore, are assumed to be susceptible.

### Footnotes

<sup>1</sup> A source flock is the flock of birth of a scrapie positive animal. If the scrapie positive animal is no longer in the flock, it must be under 72 months of age when tested for the birth flock to be considered a source flock.

<sup>2</sup> The new program utilizes a blood sample to determine the genotype of live animals, but other tissue can also determine genotype and are used in sheep that are necropsied.

<sup>3</sup> In addition to 136 and 171, codon 154 is known to play a minor role in scrapie susceptibility and is not often tested for in the U.S.

<sup>4</sup> These sheep are restricted only in rare cases when the animal is: (a) the female offspring of a female positive animal, (b) a clinical suspect, (c) from a flock with unusually high prevalence, (d) from a flock that has a history of recurrence, or (e) from a flock that included a positive sheep of a resistant genotype.

<sup>5</sup> Any AV QR that is likely to have been exposed to a strain to which it is susceptible is restricted.