R4661 – Using sheep and goat pox vaccines to control rinderpest, PPR, bluetongue and foot and mouth diseases*

*Improvement of the capripox–rinderpest recombinant vaccine through the use of alternative promoters for expression of rinderpest genes

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Executive summary

- Diseases caused by capripoxviruses affect around 650 million sheep and goats (through pox diseases) and 250 million cattle (lumpy skin disease). This constitutes a massive economic burden for many resource-poor farmers in Africa, damaging their livelihoods and opportunities to increase their income.
- The object of this project was to develop a multivalent vaccine that can control pox in sheep and goats (capripoxvirus) and act as a carrier or vector of foreign genes to help control several other major diseases of sheep, goats and cattle in Africa, the Middle East and Asia.
- A very promising recombinant vaccine was designed and produced giving short-term (and some long-term) protection for cattle and goats when challenged with lethal rinderpest virus and capripoxvirus.
- The vaccine was developed at the high-security facilities of the Institute of Animal Health, Pirbright, UK.

Project dates: April 1993 – April 1996

Background
Diseases caused by capripoxviruses affect around 650 million sheep and goats (through pox diseases) and 250 million cattle (lumpy skin disease – LSD). Many animals die and the productivity of those that survive is severely reduced. Although rinderpest has been largely eradicated from many countries it is still endemic in southern Sudan, Ethiopia, northern Kenya and Uganda and is still a problem in the north of India and Pakistan. Peste des petits ruminants (PPR), bluetongue and foot and
mouth diseases are still major problems for farmers in many developing countries.

The object of this project was to develop a vaccine that can control pox in sheep and goats (capripoxvirus) and then modify it to become a carrier or vector of different factors to help control several other major diseases of sheep, goats and cattle in Africa, the Middle East and Asia. By genetically engineering a multivalent vaccine, giving immunity against a range of related viruses, this project could help to reduce the massive economic damage caused by the pox viruses on small ruminants. It could also assist the control of other major livestock diseases including rinderpest, PPR and, eventually, bluetongue and foot and mouth diseases.

**Objectives**

This project had a number of specific aims:

- To understand the immunological and pathogenic basis of the adverse local reaction of a proportion of vaccinated cattle to the present vaccines against capripoxvirus.
- To improve a current vaccine so that it is safe to use in cattle and small ruminants.
- To map out the genome of the virus in order to identify non-essential regions into which foreign genes could be integrated and expressed without affecting the viability of the virus to replicate and for the vaccine to work.
- To construct the combination of vectors that would direct integration of the foreign genes into these nonessential regions.
- To identify, clone and manipulate, for subsequent use in expressing foreign genes, the early and late capripoxvirus promoters.
- To construct recombinant capripoxviruses expressing sequences coding for foreign antigens.
- To assess the ability of each recombinant capripoxvirus to replicate and elicit an immune response from target animals.

**Highlights**

At the high security facilities at the Institute of Animal Health, Pirbright, UK, this project designed and produced a very promising recombinant vaccine giving short-term protection for cattle and goats against poxviruses. The vaccine also gives some long-term protection to animals that have already been exposed to capripoxvirus. As the pox virus is not infectious it was not possible to modify the recombinant viruses themselves to act as vectors. Instead, the researchers had to construct completely new plasmid transfer vectors. New genes (*Escherichia coli* gpt,
fusion gene (F) and haemagglutinin gene (H) of rinderpest virus) were placed in the genome under the control of promoters able to elicit an immune response. The exact location and orientation of each of these genes was determined using nucleotide analysis. This analysis also confirmed that no changes to the elements had occurred during the manipulation process. The transfer vectors were used to prepare recombinant capripox–rinderpest viruses using standard transfection techniques.

**Impact**

The successful development of this type of vaccine could have a significant positive impact on the livelihoods of subsistence farmers and those dependent on produce such as meat, wool, leather and dairy products from small ruminants. Improved vaccines would make maintaining the good health of livestock easier and less costly. If this recombinant vaccine fully realises its potential in the next decade then a large market for veterinary vaccines would also be created.

The efficacy of the vaccine was tested in a field trial at the Kenyan Agricultural Research Institute (KARI), Muguga, Kenya (see project [R5033CB](#)).

**Related projects**

- [R5033CB](#) – Field trials of the capripox/rinderpest recombinant virus
- [R5504](#) – Inducing immune responses
- [R6557](#) – Field trialling of the capripox/rinderpest recombinant virus
- [R7048](#) – Development of a genetically marked rinderpest vaccine
- [R7362](#) – Developing a cheap and effective pen-side test that differentiates between vaccinated animals and those infected by the rinderpest virus