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# Ultrasound and CT scanning in a venison breeding programme

Prepared for

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## Introduction

Wilkins Farming Ltd have been using ultrasound since 2003 and CT scanning since 2007 to investigate how these technologies can be used to improve meat yield in their venison breeding programme. To date, industry genetic improvement programmes for venison production have focused on improving growth rates. High growth rate animals achieve slaughter live weights at an earlier age than lower growth rate animals, so there are obvious economic benefits in selection for growth rate. While efficient conversion of grass into live weight gain is important in running an efficient venison operation, the proportion of meat cuts that can be recovered for sale is also very important. Heavier animals tend to have a greater weight of meat than lighter animals, but that does not necessarily mean that the carcass has yielded well. Animals slaughtered at the same live weight can vary considerably in the weight of meat they produce. This report compiles information derived from four years of CT scanning work and summarises the results to date.

## Meat yield measurement

The weight of meat on an animal at any time can be estimated from its live weight. However, this just assumes an average dressing percentage and does not provide any information on whether the animal has more, or less, meat that we would expect at that live weight, i.e. is it high or low yielding? In order to estimate meat yield in a live animal, we have to be able to 'look inside' the body of the animal. Ultrasound and Computed Tomography (CT) are scanning machines developed for use with humans, and can be used in animals to collect body composition measurements.

### *Ultrasound scanning*

Ultrasound scanners are able to build images by sending sound waves into an animal and 'listening' for echoes of the sound waves as they bounce off boundaries between tissues. Ultrasound scanners have many features which make them attractive to use in a breeding programme: they are small and portable and so can be used on-farm; it does not take a lot of time to take an image so large numbers of animals can be scanned; animals do not have to be sedated; they are relatively inexpensive to use and there are no animal or human health implications in using the scanner. However, they can only collect measurements on muscles close under the skin and there is a limit to the size of muscle that can be measured. They also do not work well when the deer is in winter coat. As such they can only measure part of the carcass and only at certain times of the year.

The eye muscle is one muscle that can be measured accurately in deer, and is a good choice for scanning because of its high value. This eye muscle measurement can be used to give an indication of the meat yield of animals. An animal with a higher than expected eye muscle area for its live weight is expected to have more total meat yield than would be expected for that live weight. Predicted meat yield is better than prediction on live weight alone. However it does not account for differences in yield that might occur in other regions of the carcass, such as the shoulder or hindleg.

An additional measurement collected on the deer at ultrasound scanning has been the length of the back. This adds a third dimension to the eye muscle measurement and can be used to estimate the weight of the loin cut. The eye muscle area is multiplied by the length of the loin to give an approximation of the volume of the loin, and this is in turn multiplied by the density of meat to give an estimate of meat weight.

### *CT scanning*

CT scanning is another human scanner that has been adapted for use in livestock. We can collect highly accurate measurements on meat and fat in the carcass of an animal using a CT scanner. The measurements are effectively as accurate as slaughtering the animals and dissecting out the meat from the fat and bone in the carcass, but the animal is still alive after CT scanning and can be used in a breeding programme.

While accuracy of CT is excellent, there a number of limitations. CT scanners are not portable so animals have to be transported to the scanner. Animals have to be sedated and restrained for scanning, and images are collected from a number of locations so scanning takes around ten minutes per animal. CT scanners are expensive to purchase, have high running costs and use ionising radiation (X-rays) to collect the image so there are human safety regulations for people staffing the scanner. As such CT scanning is suited to taking a set of accurate measurements on a small group of animals. This means that CT scanning is used to selecting the stud sires for use in the stud rather than for animals for sale to clients. The genetic improvements made in the stud then flow on to the next crop of stags for sale.

Wilkins farming have been CT scanning since June 2007 and have scanned 70 stags from 2007 until present.

### *Estimates of the benefits of improving meat yield*

The aim of using ultrasound and CT scanning in the Wilkins Farming venison breeding programme is to improve the weight of yield of venison from carcasses. This means selecting animals that grow well and also have more meat than one would expect for a given carcass weight. This is achieved by identifying animals that have significantly higher estimated meat weights and breeding from them. The number of deer ultrasound and CT scanned by year is shown in Table 1.

**Table 1. Number of deer ultrasound and CT scanned per year**

| | Number of deer scanned | |
|---|---|---|
| Year | ultrasound scan | CT scan |
| 2004 | 60 | |
| 2005 | 60 | |
| 2006 | 60 | |
| 2007 | 150 | 12 |
| 2008 | 250 | 12 |
| 2009 | 350 | 22 |
| 2010 | 250 | 25 |
| Total | 1080 | 71 |

The relative performance of individual stags is shown in Figure 1 below, where animals that sit above the regression line have more than average meat for their live weight, and those below the line have less than average meat.

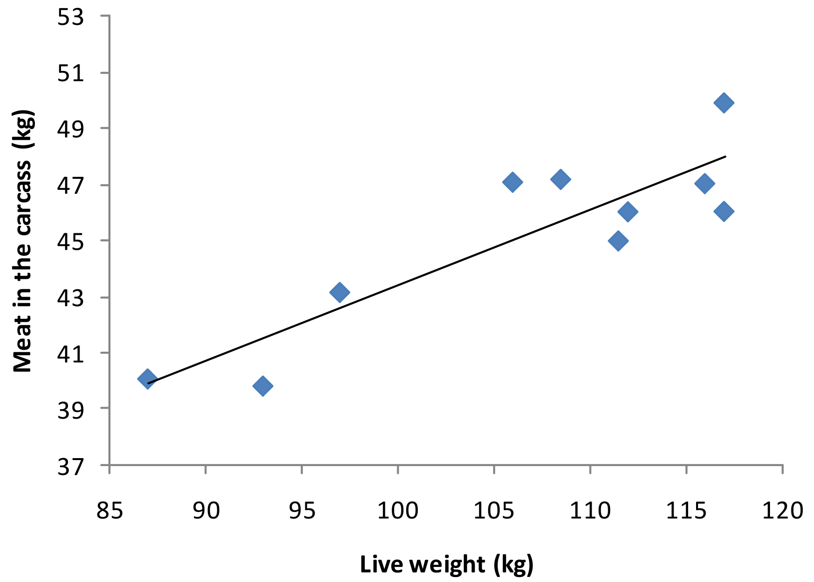


**Figure 1. Relationship between live weight and meat weight in the carcass**

Differences in meat yield have been estimated by both ultrasound scanning and CT scanning. Loin weight was estimated from ultrasonic eye muscle area images as described above (estimated from eye muscle area multiplied by the length of the animals back and the density of lean meat). There was a 1.7 kilogram differences in loin weight for between the best and worst stags over a narrow live weight range from 113 to 117 kilograms. At $7/kg carcass weight, this equates to a difference of $12 per head from the loin alone, without including any correlated increase in meat yield from the other areas of the carcass. The loin is also the highest value cut so the difference in ultimate value between best and worst yielding carcasses will obviously be much greater. Assuming an average figure of $35NZ/kg FOB could be achieved, then the difference in value between the best and worst animals was around $60.

Similar differences were observed in the CT data. The differences in meat weight between stags when compared at the same body weight were around 4.0 kg at an average live weight of 102.5 kg. Part of these differences in performance are due to environmental factor, and some is genetic and will be passed on to the stags progeny. The breeding values for a group of stags that went through the CT scanner are presented in Table 2. The breeding value is how much more or less meat we would expect to see in the progeny of a given stag, compared to the average of all of the stags. For example, if all of the ten stags in Table 2 were mated to a group of hinds, we would expect to find the average meat weight in the progeny of Stag 1 to be 0.73kg more than the average of all of the progeny, and the progeny of Stag 10 to have 0.67kg less than average. If the average for the group was 40kg of meat, then the progeny of Stag 1 would have 40.73kg on average and the progeny of Stag 10 would have 39.33kg, all other factors being equal.

**Table 2. Carcass meat breeding values**

| Sire | Carcass lean breeding value (kg) |
|---|---|
| Stag 1 | 0.73 |
| Stag 2 | 0.69 |
| Stag 3 | 0.53 |
| Stag 4 | 0.20 |
| Stag 5 | 0.06 |
| Stag 6 | -0.20 |
| Stag 7 | -0.23 |
| Stag 8 | -0.52 |
| Stag 9 | -0.59 |
| Stag 10 | -0.67 |

Selection in a venison breeding programme is not based on meat yield alone, and it always going to be balanced with selection for growth rate. If improving both growth rate and meat yield are the aims in a breeding programme, it is possible to improve meat yield over and above the improvement that come from improved growth rate. In a breeding system that ultrasound scans all of the stags and CT scans the top 10% of stags, we would expect to lose a small amount of the improvement in growth rate (340g per round of selection), this would be compensated for by improvements in the yield of meant in the hindleg, loin and shoulder regions of the carcass. The gains have been estimated at an additional 510 grams of meat per round of selection, including 270g additional in the hindleg, 70g additional on the loin and 150 grams additional in the shoulder. These gains are per round of selection and are cumulative so with five years of selection the gains would be 1343, 373 and 747g more meat in the hindleg, loin and shoulder cuts than would have been the case if the stags had only been selected on the basis of growth rates.

These gains are based on random allocation of hinds to the stud stags. Further gains can be made using ‘assortative mating’ where the best stags are mated to the best hinds, although the level of inbreeding has to be monitored using this technology.

## Summary

Ultrasound and CT scanning provide information of the yield of lean meat from a deer carcass that growth rate is not able to provide. There years of work have shown substantial differences in meat yield (lean meat weight after correction for differences in carcass weight) between sires. Single trait breeding values indicate that considerable genetic progress can be made in improving both growth rates and meat yields, although a small amount of the progress in growth rate will be sacrificed if meat yield is part of the breeding objective. The next step for Wilkins Farming is to implement this in a multi-trait analysis of growth rate, eye muscle area and lean meat yield from carcass cuts.