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Pregnancy diagnosis using ultrasound

By M. A. Johns, Technical Officer, Sheep and Wool Branch

Few Western Australian ewe flocks are diagnosed for pregnancy despite the presence of high numbers of barren ewes. Surveys of farm flocks in the early 1970s recorded that between 14 and 29 per cent of ewes failed to lamb each year.

Since then, changes have affected the breeding ewes' contribution to farm income and so the problem of barren ewes assumes greater significance. These changes include an increased proportion of breeding ewes in flocks, and the need for supplementary feeding because of the trend towards autumn lambing. They make it more important for farmers to improve ewe fertility and to diagnose pregnant and barren ewes early in the mating cycle.

Techniques for diagnosing pregnant ewes have been available for many years, but ultrasonic devices and computer technology have made it possible for skilled operators to determine whether ewes are pregnant and, more importantly, whether they have one, two or more foetuses.

Once the number of pregnant ewes is known farmers can use labour more efficiently. They can minimise the cost of supplementary feeding, particularly if the use of diagnostic techniques identifies ewes bearing twin lambs. Failure to carefully manage a flock with multiple lambs could lead to reduced wool production per head, reduced lamb growth and more ewe and lamb deaths.

Other diagnostic techniques

Pregnancy diagnostic techniques vary with the equipment used, labour requirements, cost, reliability, experience required to operate the equipment, safety to the ewe and unborn lamb, and the stage of pregnancy when reasonable accuracy can be obtained. Thus the potential use of pregnancy diagnostic techniques in improving the management of ewe flocks varies considerably.

The following techniques, when used correctly, can give a reliable diagnosis of pregnancy in ewes.

- Examination of the udder during the four weeks before the start of lambing.
- Use of harnessed 'teasers' (vasectomised rams or hormone-treated wethers) after joining.
- Abdominal palpation in the last two months of pregnancy.
- Rectal probe palpation during the last three months of pregnancy.
- Laparoscopy, a surgical operation which may be performed after the 25th day of pregnancy.
- Analysis of blood samples to measure the amount of progesterone on the 18th day after mating.

Ultrasonic devices

With skilled use, ultrasonic devices are the most accurate and useful method of diagnosing pregnant ewes and the number of foetuses.
Ultrasound is sound that humans cannot hear, above 20,000 hertz. A hertz is a unit of frequency equal to one cycle per second. Diagnostic ultrasound operates in the range 1 to 10 megahertz (a megahertz being 1,000,000 hertz). For pregnancy diagnosis the range is two to five megahertz. At this high frequency, ultrasound pulses are safer on living tissues, even delicate foetal tissues, than are x-rays.

**How ultrasound works**

To generate sound of such high frequency, an extremely small object is made to ring or vibrate. For ultrasound a piezoelectric quartz crystal, about the size of a match head, is used. When a voltage is applied to a piezoelectric crystal it changes shape, and when the voltage is switched off the crystal resumes its original shape. Frequent voltage pulses cause the crystal to change shape rapidly and vibrate. If a piezoelectric crystal is made to vibrate five million times a second, the ultrasound produced is measured as five megahertz.

A piezoelectric crystal not only gives off ultrasound, but it can also receive returning sound waves. It converts applied electrical energy into ultrasonic energy (vibrations) and alternatively can convert mechanical energy (echoes) into electrical energy. The hand-held probe or transducer that houses the crystal(s) can be used to transmit energy and to detect the returning echoes.

When ultrasonic waves meet a boundary or interface between two substances of varying density and stiffness such as tissue, liquid, gas or bone, some of the sound waves are echoed back to the probe. Substances with similar characteristics such as muscle and liver reflect only a small proportion of sound waves. The remaining waves continue on through the body to provide information about underlying interfaces. This is important because any interface that reflects a large proportion of sound waves will not leave sufficient to provide information about deeper lying structures.

The two types of ultrasonic devices for diagnosing pregnancy in ewes being used in Western Australia are echo ranging and real-time scanning. A third device, the doppler unit, can be used with an external probe or a rectal probe to detect movement of blood in the foetal heart. It is seldom used because of inaccurate diagnosis and the extra time taken to examine each ewe. This article only discusses echo ranging and real-time scanning.

**Echo ranging**

Echo ranging is used to detect the large fluid-filled uterus of a pregnant ewe. The two models used in Western Australia—Pregtone® and Scanopreg®—are powered by re-chargeable batteries. Each model contains one piezoelectric crystal in the probe. Ultrasound sound waves are emitted from the probe into the ewe’s abdomen, and the probe receives returning sound waves that are echoed back from the interface variation between tissue, gas and liquid. Because sound waves readily pass through liquid, and the uterus of a pregnant ewe is a fluid-filled sac containing the foetus, fewer echoes are received by the probe.

Echo ranging devices are programmed to recognise this lack of echo and so indicate a pregnant ewe. If a ewe is pregnant, the device emits an audible sound. The Scanopreg® also has a system of red and green lights to indicate pregnancy.

In 1986, the Scanopreg® cost $1,200, twice the cost of the Pregtone®. Their accuracy of pregnancy detection is similar from the 66th day of pregnancy (Figure 1). Knowledge of the ewe’s anatomy helps us to understand how echo ranging devices detect pregnancy.

![Comparison of accuracy of pregnancy detection for Pregtone® and Scanopreg®.](image)

When using an echo ranger, the probe’s position on the ewe’s bare skin and its ‘aim’ are important to accurate diagnosis.
In a barren ewe the uterus is small and contains little or no fluid. The uterus of a pregnant ewe contains one or more foetuses and fluid—about 750 millilitres for a single lamb or about one litre for twins at the 65th day of pregnancy. As pregnancy progresses the uterus enlarges and is pushed to near the right flank by the rumen, which is on the left side. The bladder is at the back of the pelvic cavity, and when full, can give a 'signal' to the echo ranger indicating pregnancy. Before testing, therefore, ewes must be yarded without water overnight.

Ewes can be tested lying on their backs or standing. Experience has shown that a crutching cradle in which the ewe lies on her back is ideal. Also a raised race that allows ewes to be tested in the standing position has been used successfully.

The probe face must be covered with a light oil such as vegetable oil to give an air-free contact between it and the ewe's skin. It is placed on the area of bare skin inside the ewe's right flank and 'aimed' at an angle of 45 degrees into the body and about 30 degrees forward, that is towards the foetus. The probe's position on the skin and its 'aim' are important to accurate diagnosis. Ewes in full wool can be a problem as the wool tends to wipe the coupling fluid from the probe.

It is best to identify the barren ewes and re-test them at the end of the day. With the second test up to five per cent of those ewes previously diagnosed as barren may be correctly diagnosed as being pregnant.

For satisfactory pregnancy detection with more than 95 per cent accuracy, ewes should be tested between the 65th and 120th days of pregnancy. If echo ranging is used before the 65th or after 120th day of pregnancy, accuracy is reduced. Ewes joined for six weeks should be tested 110 days after the start of joining. If the joining period is longer than six weeks it is worthwhile to test twice, with the first test 90 days after the start of joining and the second test 40 days later. Pregnant ewes detected at the first test should be identified and not tested a second time. As these ewes will be the first to lamb, they may be drafted off and managed as a separate flock.

Real-time scanning
The most accurate and rapid technique for determining pregnancy and the number of foetuses is real-time ultrasonic scanning. The machine used is similar to that for scanning pregnant women. The size and cost of these machines has been reduced, from $30 000 three years ago to $10 000 in 1986. Should this trend continue, sheep studs, farmer co-operatives or contractors may find it economical to use them.

The probe of a real-time ultrasonic scanner contains many piezoelectric crystals. High frequency sound waves are emitted by the rapid, sequential excitation of these crystals by electronic switching and the crystals then receive the returning sound waves. After processing, the echoed sound waves are displayed as an image on a small black and white screen similar to a television screen. The whole of the fluid-filled uterus can be searched by manipulation of the probe. If the ewe is pregnant, the number of foetuses can be seen moving on the screen. Even the foetal heart can be seen pulsating in a ewe that is more than 30 days pregnant.

With real-time scanning the ewe must be thoroughly prepared for examination. Wool should be closely shorn from the udder, up the full width of the belly for a distance of about 20 centimetres. A 90-day pregnant ewe has a uterine mass that will occupy this area. The shorn area is painted with vegetable oil, which can subsequently be scoured out, to give an air-free contact between the probe and skin. The ewe is laid back with the hind legs restrained, while the handler is seated holding the ewe's forelegs. The probe is placed on the ewe's belly and moved over the whole oiled area.

With this machine fluid can be detected in the uterus by the 25th day of pregnancy. By the 40th day pregnancy can be detected with 100 per cent accuracy and the number of foetuses with an accuracy of 95 per cent or better. This degree of accuracy is maintained between the 40th and 120th days of pregnancy.

To achieve this accuracy operators must learn the correct testing procedures and gain experience. An experienced operator can scan 80 to 100 ewes an hour with a high level of accuracy in a normal Merino flock. With more fertile ewe flocks with a higher proportion of multiple foetuses the rate could drop to 50 to 60 ewes an hour.

Training
To make best use of a real-time scanner, operators should be capable of scanning highly fertile ewe flocks with an accuracy above 95 per cent. A training course was organised for two operators from the Department of Agriculture’s Sheep and Wool
Branch and two from the University of Western Australia at the University's Allandale Research Station, Wundowie in 1984.

Two hundred Booroola ewes were joined for two cycles. One hundred ewes were selected for scanning twice every two weeks by each operator, six times in all. The 100 ewes consisted of 17 barren ewes, 35 with one foetus, 33 with two foetuses and 15 with three foetuses, making them a highly fertile group.

Experience gained has proved invaluable for the operators when they started scanning their research flocks. No one should attempt to use a real-time scanner without first going through an intensive training programme.

**Costs and benefits**

The costs and benefits of pregnancy diagnosis must be assessed before deciding to identify pregnant ewes.

The costs will depend on the technique used and whether it is done by a contractor.

The benefits will depend on the particular situation.

- Where there is a shortage of paddock feed, pregnant ewes can be given the best pasture.
- When ewes are fed supplements the ration can be varied for barren and pregnant ewes.
- The flock can be divided into barren ewes and early and late lambing ewes. This allows better supervision at lambing. Lambs can be marked and mulesed in suitable age groups without disturbing recently lambed ewes.
- Pregnant ewes can be retained when sheep numbers are reduced due to poor seasonal conditions.
- Diagnosis may indicate the cause of low lambing percentages. At lamb marking it can be difficult to identify ewes that have lambed but did not rear it from those that did not lamb.

Real-time scanners are valuable research tools, but their widespread use in commercial flocks is unlikely. In many Western Australian commercial flocks twinning rates are low, less than 20 per cent. Little if any increase in financial returns would be generated by identifying these animals, given present lamb prices. The major reproductive loss facing commercial flocks is the high proportion of barren ewes. These ewes can readily be identified using echo-ranging devices.

The use of improved management and breeding techniques could increase the numbers of ewes bearing twins. The real-time scanner, therefore, could eventually have a place in our commercial flocks.

Unlike other pregnancy testing techniques, the real-time scanner can identify ewes carrying more than one foetus. Knowledge of the number of foetuses lets the farmer manage his ewe flock better.

- Pregnancy toxaemia can be reduced because the ration of pasture and supplementary feed can be varied for ewes with none, one or two foetuses.
- Ewes bearing twins can readily be identified, making genetic selection for improved reproduction easier and more accurate.

The disadvantage of real-time scanning is its high labour cost. Current research is seeking to reduce labour costs and to increase the scanning rates with semi-automatic techniques.

**Further reading**


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