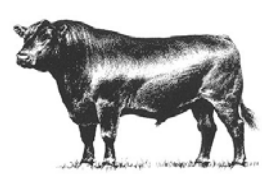
INTERNATIONAL STUDY GUIDE

REAL-TIME ULTRASOUND
BEEF CATTLE APPLICATIONS

RIB FAT THICKNESS
RUMP FAT THICKNESS
EYE MUSCLE AREA
INTRAMUSCULAR FAT



OPERATOR TRAINING MANUAL
for
TelaVet 1000

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Classic Medical

Foreword

The first Operator training manual was produced in the late 1990's with the intent of providing background information on the development of hardware and software for the objective evaluation of meat animals. This coincided with the rapid increase in the opportunity for using real-time ultrasound to determine objective measurements for economic traits such as thickness of backfat and rump fat, size of loin eye muscle and intramuscular content of potential breeding animals. The technology was quickly grasped by breeders and breed association charged with making genetic improvement in producing animals and using the data from these evaluations to enter into a breed's database to generate Expected Progeny Differences (EPD's) that might be used in genetic improvement programs for beef cattle (Crews et al., 2004), sheep and swine. **This operator manual is written to cover the technology associated with the TelaVet 1000 ultrasound machine marketed by Classic Medical**. Classic Medical has offered high quality veterinary ultrasound systems since 1985 along with useful imaging supplies for the veterinary/animal science marketplace. The purpose of this manual is to provide a better understanding of the history and mechanics of ultrasound technology and to outline methods for the utilization of the TelaVet 1000 in the evaluation of carcass characteristics.

Background and History of Ultrasound Technology

Ultrasound technology has made a significant impact on the animal science industry. Real-Time ultrasound has increased in popularity over the past decade and is currently utilized extensively in numerous sectors of animal science. Ultrasound technology serves as a tool for breed associations to predict carcass characteristics to be used in the calculation of Expected Progeny Differences, by stockers and feedlots to predict carcass merit, and by veterinarians in the observation of reproductive psychology. Furthermore, as more advances in ultrasound technology arise opportunities will progress for use in other segments of the industry.

The ultrasound technology commonly accepted dates back to 1880 with the development of the piezoelectric crystal. However, most first remember either hearing or reading about ultrasound in the form of SONAR (SOund NAvigation and Ranging) used in military applications in the 1940's. In the early 1950's, researchers (Wild, 1950) began reporting using A-mode (amplitude modulation) for ultrasonic imaging of biological tissues. The technology continued to progress until today B-mode (brightness modulation) is a widely used technology for imaging tissue. While A-mode is one-dimensional and is limited to measuring depth of tissue, B-mode allows characterization of tissue with different densities.

Ultrasound is a high-frequency sound wave. While audible sound waves are of the order 20-20,000 hertz (Hz) (cycles per second), ultrasound waves are in the 1-10 megahertz (MHz) range (Goddard, 1995). An ultrasound image is generated when an electrical current is applied to the piezoelectric crystal located in the transducer generating sound waves that are then directed into the tissue. The sound wave travels through the biological tissue until it strikes a tissue of a different density and an echo is returned to the transducer. This echo is converted back to an electrical signal and interpreted by the instrument as variations in brightness displayed on the cathode ray tube of a B-mode system as a dot. The brightness of the dot depends on the amplitude, or intensity, of the echo. The time it takes the echo to reflect back to the transducer determines the location or position of the dot or pixel on the screen. The B-mode units use grey scale numbers ranging from 1 to 64, and the final image is generated by differences in shades of gray generated from the tissue field. Dense tissues give a bright, white echo (pixel) while lesser density tissues are seen as grey pixels.

Animal tissues have different densities, characterized by differing velocity of propagation through the tissues. Therefore these differences allow the use of ultrasonics to characterize these tissues for different purposes. Velocity for common food animal tissues (Powis, 1996) is:

TISSUE	**VELOCITY (m/s)**
Blood	1,549-1565
Fat	1,476
Connective tissue	1,545
Skeletal muscle	
Longitudinal	1,592
Cross-sectional	1,545
Bone	3,406-4,030
Scanner calibration	***1,540***

Distance can be calculated as:

$$\textbf{Distance} = \frac{\textbf{time x velocity}}{\textbf{2}}$$

Real-time ultrasound is a specialized version of B-mode ultrasound producing images almost instantaneously thereby creating “live”, moving objects. By using a liner transducer with multiple crystals emitting a continuous beam of ultrasound pulses, a picture of the scanned area can be recorded and interpreted.

Commonly Used Terminology

Competent operators should have a basic understanding of the terminology associated with ultrasound and food animal scanning. The following terms are commonly used in the industry:

AUP **–** Association of Ultrasound Practitioners, an organization that certifies proficiency of operators based on pre-established standards.

Absorption - Loss of energy (principally due to molecular friction forces and the production of heat). As frequency increases, absorption increases.

Acoustic coupling - Since ultrasound is poorly transmitted through air, it is necessary to exclude air and link the transducer to the surface of the subject with a suitable coupling gel.

Acoustic enhancement - Tissues distal to an anechoic structure may display enhanced echogenicity.

Acoustic interface - Junction of two tissues with different acoustic impedance. This leads to the reflection of a proportion of the incident beam and possible diffraction of much of the remainder of the beam. The greater the difference in acoustic impedance, the stronger the reflection.

A-mode - Amplitude modulation. A one-element (one dimensional) display with time (distance) on the horizontal axis. The relative strength of the echo is registered as amplitude on the vertical axis.

Amplitude - Height of the ultrasound waveform.

Anechoic **(sonolucent)** - A tissue failing to reflect the ultrasound beam produces no echoes (e.g. a fluid-filled viscus).

Anterior - Toward the head, may also use *cranial*.

Array - Distribution of crystals along the length of a linear scan head.

Artifact - An on-screen representation of a structure which does not exist or is incorrectly located.

Attenuation - Decrease in power of the ultrasound beam, caused principally by absorption, scatter and reflection.

AutoQuip **–** method of estimating intramuscular fat (marbling) in beef cattle without need of off-line (computer) processing.

Axial resolution - Measure of the ability of the system to differentiate two structures lying closely together along the path of the ultrasound beam.

B-mode - Brightness modulation. A compound A-mode scan with amplitude translated into a brightness scale. Location on the display is related to position and depth.

Beef Improvement Federation - Established in 1968 to standardize programs and methodology and to create greater awareness, acceptance and usage of beef cattle performance concepts. This organization originally established standards of proficiency for certification evaluation.

Bias - Average deviation of an operator’s estimates from the carcass measurements. Bias is used to standardize measurements between different technicians.

CPEC **–** Cattle Performance Enhancement Company, technology used to sort U.S.

feedlot cattle into uniform outcome groups.

Calipers - A system for measurement of distance and area is provided on most instruments.

Caudal - Toward the tail, may also use *posterior*.

Certification - A proficiency-testing program generally offered at least twice per year. The certification program for beef operators is intended to evaluate operator proficiency against standards established by AUP, CUP or other certifying organizations. Most breed associations will only accept data or images from certified operators.

Cranial - Toward the head, may also use anterior.

CUP – Centralized Ultrasound Processing was established to provide centralized image interpretation of ultrasound images generated in the field by certified technicians. The technicians acquire images according to certain specifications and then forward these images to a CUP approved laboratory for interpretation and reporting.

Diffuse reflection - An echo from a target(s) less than one wavelength in size.

Distal - Away from the body in a limb of the animal.

Doppler ultrasound - When an ultrasound beam meets a moving object the reflected ultrasound is either of increased or decreased frequency, depending on whether the motion is towards or away from the transducer. Either continuous or pulsed Doppler can be used and some systems can display compound information.

Dorsal - Toward the upper part or back of the standing animal.

Echogenic - A structure causing a marked reflection of the ultrasound beam. A change in echogenicity in a homogenous structure may indicate a pathological change.

Ether extractable fat - Chemical fat determination to estimate *intramuscular fat* or *marbling* in meat.

Focal area - Region of the scanned field where resolution is greatest. Focusing can be achieved by electronic or physical means.

Frame rate - The frequency with which images are updated on the screen. Altering the frame rate may improve image quality in some applications.

Frequency - Number of ultrasound waves emitted per second. One (1) cycle per second = 1 hertz (Hz).

Gain - The amplification level of a returned signal. On some instruments different depths of the field are handled separately. Incorrect setting of gain controls will lose detail from fine structures.

Grey scale - Range of intensities displayed on the cathode ray tube.

Hyperechoic - Showing increased echogenicity.

Hypoechoic - Showing decreased echogenicity.

Intramuscular fat - Fat that is deposited within muscles and appears a delicate pattern of wavy lines in the meat, also known as *marbling*.

Lateral - Toward the sides of the standing animal.

Lateral resolution - Measure of the ability of the system to differentiate two structures lying side-by-side at the same distance from the transducer.

Linear array - Distribution of piezoelectric crystals along the length of a scan

Longitudinal - Plane running lengthwise, parallel to the mid-line of the animal.

M-mode - Motion mode. Essentially a rapidly updated one-dimensional B-mode display with time on the second axis to allow study of moving structures. Used principally in cardiology.

ManQuip **–** Multiple measurement technique for intramuscular fat estimation in beef cattle using off-line computer program with QUIP index.

Marbling - Common term for intramuscular fat.

Medial - Toward the midline, plane that separates right and left sides of the body.

Piezoelectric crystals - Crystals of materials such as lead zirconate-titanate, capable of converting applied electrical energy to mechanical deformation and vice-versa.

Posterior -Toward the tail, may also use *caudal*.

Power - Energy of the ultrasound beam. It is generally expressed in watts (or as intensity in watts cm^{-2}). The minimum power consistent with good image quality should be employed.

Probe - The transducer array and its housing

Proximal - Toward the body in a limb of the animal.

QUIP **–** Quality Ultrasound Index Program, Pie Medical's proprietary tissue analysis system to characterize areas of loin eye muscle for aid in estimation of intramuscular fat (marbling) in beef animals.

Real-time - Images generated from reflected ultrasound following sequential activation of the transducer array are displayed on the screen at sufficient speed to give the appearance of a live image.

Reverberation echo - An artifact created by the retransmission of a strongly reflected ultrasound signal. The display may show several images of a single structure, which appear at increasing distances from the transducer.

Scan converter - A component of the processing system that converts the electrical output of the transducer to the cathode ray tube image, essentially by aggregating sequential arrays across the screen. A scan converter allows for subsequent analysis beyond the screen display (post-processing) and the use of standard TV accessories.

Scatter - When the ultrasound beam encounters a small object in its path the beam energy is spread in all directions.

Sector scan - A pieslice/sector-shaped image is produced on the screen. The initial signal is produced by a single vibrating piezoelectric crystal or a small number of rotating crystals (although an electronic phased linear array can produce a sector image). The scan head only needs a limited contact area (small footprint).

Shadowing - Caused by severe attenuation of the ultrasound beam such that it fails to penetrate sufficiently deeply.

Specular reflection - A strong echo created by a highly reflective tissue interface representing an area significantly larger than one wavelength.

Standard error of prediction (SEP) - Standard deviation of the differences between real-time ultrasound and carcass measurements for a given operator. SEP measures the ability of the technician to rank or predict differences between animals correctly.

Time-gain compensation (TGC) - Since the ultrasound beam is increasingly attenuated as it travels deeper into tissue, by applying TGC tissues of similar reflectivity are

represented with similar brightness, regardless of distance from the transducer.
Transducer - The piezoelectric crystal or element which converts electrical to mechanical energy.
Ultrasound - Sound of a frequency above that perceived by the human ear. Diagnostic ultrasound lies in the 1-10 MHz region.
Velocity - Speed of travel of the ultrasound wave. In tissue this is usually density dependent and ranges from 1500 to 1600 m/s^{-1}. An average of 1540 m/s^{-1} is usually adopted.
Ventral - Toward the lower part or belly of the standing animal

UNDERSTANDING THE EQUIPMENT

While there are numerous brands and models of equipment marketed by different companies, all possess the same basic components. These components include the scanners, transducers, and standoff pads.

Scanners

The basic function of the scanner is to process the image acquired by the transducer and to display this image on the screen. Units used for live food animal work are portable and can be used for both reproduction and composition work. The TelaVet 1000 (Fig. 1) can be used for a multitude of scanning purposes, depending on the selection of transducer. The system is PC based allowing you to view, capture, store, and recall quality digital images. The TelaVet 1000 system functions as a normal computer with a specialized program capable of freezing images, analyzing images, and other functions built into the system. Images can be stored on the PC in the magnitude of over 30,000 images, or can be downloaded to other storages devices such as CD's or jump drive devices. Since this system is computer based, it provides easy access to printing, networking to other computers, or e-mailing images. Furthermore, other computer software can be added to the computer to add ease to record keeping.

Figure 1. TelaVet 1000 PC based scanner in its hard sided case.

Transducer

The transducer (probe) is the "eye" of the scanner. At the heart of the transducer are the piezoelectric crystals generating ultrasound pulses across its axis, sending the generated beams into the tissue and receiving the echoes to be processed by the scanner. The

TelaVet 1000 supports a wide range of variable frequency linear, convex and microconvex array probe heads (Fig. 2). The recommended transducer for most food animal scanning applications is the Animal Science Probe. This probe contains a total of 128 piezoelectric crystals arranged in a linear array. The probe is a full 18 centimeters in length, allowing for single scan imaging for all food animals (beef, sheep, swine and meat goats).

Figure 2. TelaVet 1000 animal science probe

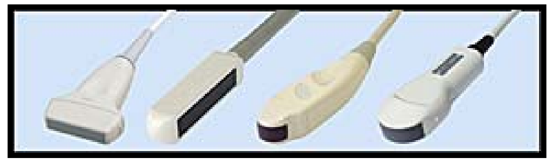


Figure 3. Probes available for the TeleVet 1000 system.

Standoff Pad

A standoff pad (wave-guide) is used to "fit" the straight, linear array transducer to the curved back of the animal for image acquisition. The standoff pad (Fig. 4) is essential for measuring cross-sectional loin eye muscle area. The pad is not required for longitudinal scanning common for rib fat, rump fat, muscle depth or intramuscular fat estimation.

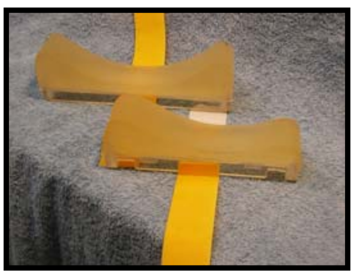


Figure 4. Standoff pads with Velcro

SPECIALIZED FOOD ANIMAL SCANNING

During the last 40 years, a considerable amount of research effort has been directed at developing non-invasive, non-destructive techniques for assessing composition and quality of live beef animals and beef carcasses. Real-time ultrasound (RTU) has emerged as a cost effective and reliable method of estimating composition and quality of live beef animals (Houghton and Turlington, 1994). Ultrasound as a means of predicting carcass merit is relatively inexpensive, has a shorter generation interval when compared with carcass sire progeny testing programs, and the data provided via ultrasound may be subject to less selection bias than carcass data collected via sire progeny testing programs. Studies have concluded that RTU imaging gives an accurate and repeatable measure of external fat thickness and longissimus muscle area if ultrasounding is conducted by trained technicians (McLaren et al., 1991; Perkins et al., 1992a,b; Herring et al., 1994). More recently, (Hasssen et al., 2001; Chambaz et al., 2002) showed that ultrasound technology has become a well established and accepted method for prediction of intramuscular fat in live cattle. Most of these technologies have used an off-line computer image interpreting system for composition (Hamlin et al., 1995a; Hamlin et al., 1995b) and muscle quality (Whittaker et al., 1992; Brethour, 1994, 2004; Wilson et al., 1995). However, recent advances in RTU technology have made this technology more user-friendly and available to the practicing veterinarian and producer.

Producers and researchers involved with the food animal industry are well aware of the applications of RTU for food animals. However, most veterinarians have normally thought of RTU in terms of injury diagnosis and reproductive physiology applications only. Some additional uses of RTU in the food animal industry include:

Reproductive Physiology

1. **Pregnancy detection**
2. **Fetal sexing**

There are several uses of RTU in reproductive physiology (Beal et al., 1992). One specific use is to monitor ovarian activity to increase the number of cyclic cows and heifers to aid conception. This might include evaluation prior to the breeding season or toward the end of the artificial insemination (AI) breeding season. This can then be followed by pregnancy detection as early as 9 days (Boyd et al., 1988). Fetal sexing is also possible as early as 48 days (Muller and Wittkowski, 1986; Wideman et al., 1989). This is of particular importance to the purebred beef producer in that male calves are generally of greater economic value than female calves.

Carcass Composition and Quality

1. **Backfat (subcutaneous fat) determination**
2. **Rump fat determination**
3. **Loin eye muscle area**
4. **Muscle quality by intramuscular fat estimation**

Composition and quality of beef carcasses are the driving forces behind interest in a value-based marketing system. The feedlot operator and packer are both interested in the ability to produce carcasses of consistent composition and quality. RTU offers the ability to accurately assess subcutaneous fat that is a prime contributor to variation in lean composition of animals of similar weights (Faulkner, et al., 1989). The Australian P8 site fat measurement may also be used to estimate composition in the live animal, especially for leaner cattle (Rouse et al., 1995). Loin eye muscle area (LEA) is of particular importance to seedstock producers selecting for muscling in breeding animals (Wilson et al., 1995) as well as to estimate composition in market animals. Intramuscular fat is highly related to market quality (Savell et al., 1986, Chambaz, 2002).

Performance Evaluation

1. **Sort feeder cattle into uniform production groups**
2. **Estimate quality potential of young cattle**

3. **Estimate days on full feed required for quality endpoints**

Feedlot operators are continually seeking ways to increase the efficiency of production of beef. RTU can be used to sort cattle into uniform groups based on subcutaneous fat and muscling so that these cattle will finish at a uniform weight with consistent composition (Houghton, 1988; Wall et al., 2004). Houghton et al. (1990) reported that ultrasonic measurement of backfat measurements for feeder cattle are more highly correlated to carcass fat than visual estimates.

While this publication is devoted to more heavily to applications in the beef industry, operators should also realize the same type of image analysis may be performed on other species of food animals, especially swine, sheep and meat goats with minor adjustments.

SCANNING LIVE BEEF CATTLE

Animal restraint and scanning site preparation

A great advantage in using RTU is that it is non-invasive and relatively free of stress to the animal. The scanning operation requires no special handling equipment for the animal other than those items of equipment normally found on farms or ranches and in clinics. To reduce animal stress and reduce chance of injury to the animal and operator, most find that the best location for the scanning operation is in a livestock squeeze chute or crush (Fig.5).

Figure 5. Typical livestock restraint device (chute/crush) suitable for scanning beef animals. (Courtesy of W-W Livestock Systems).

Figure 6. Restraint of beef cattle for scanning.

The animals should be moved to the chute or crush with as little stress as possible. The head should be safely secured in the head gate and checked to insure that there is sufficient freedom to not cause choking or any other type of injury to the animal. When the operator has safely secured the animal, any of the previously described scanning operations may be performed (Fig. 6) including backfat, rump fat, loineye area and muscle quality characterization. The two sites most commonly used in beef cattle scanning are the region of the 12th and 13th rib and the rump, or Australian P8 site. Site preparation is similar for all scanning operations. To obtain good acoustical contact, some operators prefer to ***clip the hair*** from the site before scanning. While this might be the ideal situation for scanning purposes, this may not always be practical (i.e., time restraints, show or exposition cattle, sorting feedlot cattle). If the scanning site has not been clipped, the operator may improve image quality by insuring the removal of loose hair and dirt by use of a brush or metal comb. RTU technicians/operators are well aware of the need for good acoustical contact between the probe and skin surface since sound waves will not travel through air. Human applications use a scanning gel for acoustical contact, however, the use of gel for beef cattle scanning may be expensive and impractical since it will be difficult to get gel into the hair coat without air pockets. Therefore, food animal scanning requires the use of ***vegetable oil*** for this purpose (Fig 7). This couplant is readily available, inexpensive and is not harmful to the animal, operator or probe. **(MINERAL OIL SHOULD *NEVER* BE USED SINCE IT IS HARMFUL TO THE PROBE SURFACE AND CABLES).** Since most scanning operations are done outdoors under less than ideal environmental conditions, oil temperature may have an influence on image quality. Best results are obtained when oil temperature is near 80° F (27° C). This keeps the oil free flowing and allows better penetration into the hair coat. Operators are encouraged to acquire a portable, insulated heater (Fig. 8) to maintain the scanning couplant at the suggested temperature.

Figure 7. Palpation of scanning site and application of acoustical couplant (vegetable oil).

Figure 8. Thermoelectric heating and cooling unit suitable for maintaining scanning oil (Igloo Koolmate

It is apparent from observing the straight linear array probe that some type of adaptation would be necessary for cross-sectional scanning of loin eye muscle area. Therefore, an acoustical contact (Fig 4) is available as an accessory for each of the units. Contacts of varying curvature are available for either beef or swine scanning. The contact is easily attached to the probe and a small amount of scanning gel is used to assure complete acoustical contact between probe and the curved pad. The quantity of gel used may depend on animal conditions and operator preference. However, temperature of contact pad and gel may again play a role in image quality, especially in colder climates. Best results are obtained when the contact pad and acoustical gel are also maintained near oil temperature. Pads should be cleaned with warm soap and water after each use and stored in a suitable container to prevent damage and drying out of the flexible material. Pads should last indefinitely if cared and stored as recommended.

Loin Eye Area Scan

A cross-section scan at the 12th and 13th rib is necessary to detect loin eye muscle area (LEA). A simple recollection of animal anatomy will insure the proper selection of the scanning site. The easiest method of site selection will be for the operator to palpate for the separation of the 12th and 13th rib (Fig. 9).

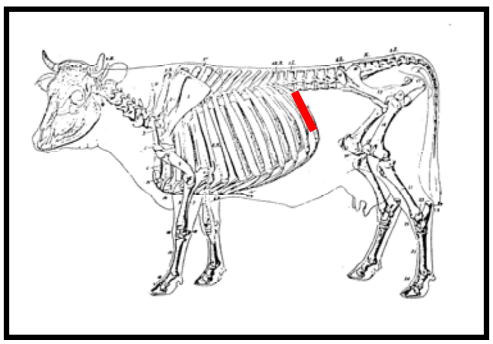


Figure 9. Skeletal illustration of selected 12th/13th rib scanning site. (Illustration adapted from Sisson and Grossman).

Figure 10. Palpation of scanning site and probe placement for cross-sectional scanning at 12th/13th rib.

The operator can now simply follow the separation of the ribs vertically and locate the proper scanning site. This site can now be prepared as previously described. The probe (equipped with contact pad) is now placed along a plane that will be parallel to the area between the 12th and 13th rib (Fig. 10). An image similar to that illustrated in Figure 11 should be visible on the monitor screen.

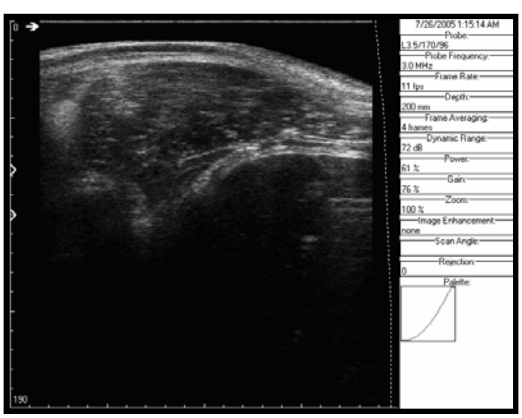


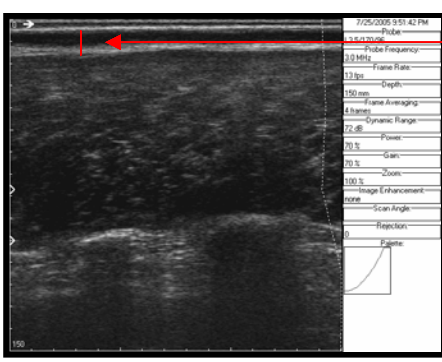
Figure 11. Image from TeleVet 1000 identifying the loin eye muscle scan.

For best results, it is recommended that a scanning depth of 6 in. or 15 cm. should be used for beef cattle scanning. Unusually large animals may require a greater scanning depth. Focal points may be adjusted for maximum image quality and brightness according to individual operator preference. Certain reference points should be readily visible that will identify a high quality image (Fig 11). Operators should see three distinct outer, parallel curved lines. The outermost line will be the outer surface of the skin or animal hide. The middle line will be the interface of hide and top surface of the fat layer. The innermost line of the three will be the reflection of the interface of the bottom surface of the fat layer and the top surface of the *longissimus dorsi* (loin eye) muscle. The loin eye muscle should be very visible to include both lateral and medial surfaces with the intercostals visible at the bottom of the loin eye muscle. When a good, high quality image is visible, the operator should depress the **FREEZE** button by using the remote button on the probe or the button on the keyboard. Once the image has been frozen, chute (crush)-side interpretation may be performed (Gresham, 1995; Gresham, 1996). To measure loin eye muscle ara (REA) select the drawing icon located in the top left corner of the screen and trace the outer edge of the muscle back to the original starting point. Muscle area in square inches, or square centimeters, will appear in the data box.

Determination of Backfat thickness

To measure backfat thickness a scan is taken longitudinal with the probe (but without the use of the standoff pad). The probe should be placed centered on the area between the 12th and 13th rib as demonstrated in Figure 7. The operator must palpate the 12th and 13th rib and place the probe above this site (Figure 13). A similar image to the picture in Figure 14 should be seen on the screen.

Figure 13. Location and proper placement of the probe for backfat and intramuscular fat predictions.



Backfat Layer

Figure 14. Ultrasound image to measure backfat.

To estimate backfat thickness, select the line drawing tool located in the top right corner and draw a line measuring the subcutaneous fat layer as demonstrated in Figure 14.

Estimation of Marbling Score

Animal preparation and acoustical couplant is the same for this analysis as previously described. The same image may be used from the backfat scan or a new image may be chosen using the same techniques describe in the backfat section. An image similar to that illustrated in Figure 15 should be visible. Then use the box drawing tool located in the top left corner to draw the box. The box should be 0.5 inches (1.25 cm) below the fat layer. This placement will insure freedom from echoes generated by tissue separation of fat and the top of the loin eye muscle. Furthermore, the analysis box should be area above region between 13th rib and 1st lumbar vertebrae and over 1st lumbar vertebrae as displayed in Figure 15.

Additionally, muscle depth may also be measured on this image which is used in the calculation of the marbling score. To measure muscle depth, use the line drawing tool (the same tool used for measuring backfat) and draw a line from the bottom of the subcutaneous fat layer to the muscle image located toward the bottom of the screen as shown in Figure 15.

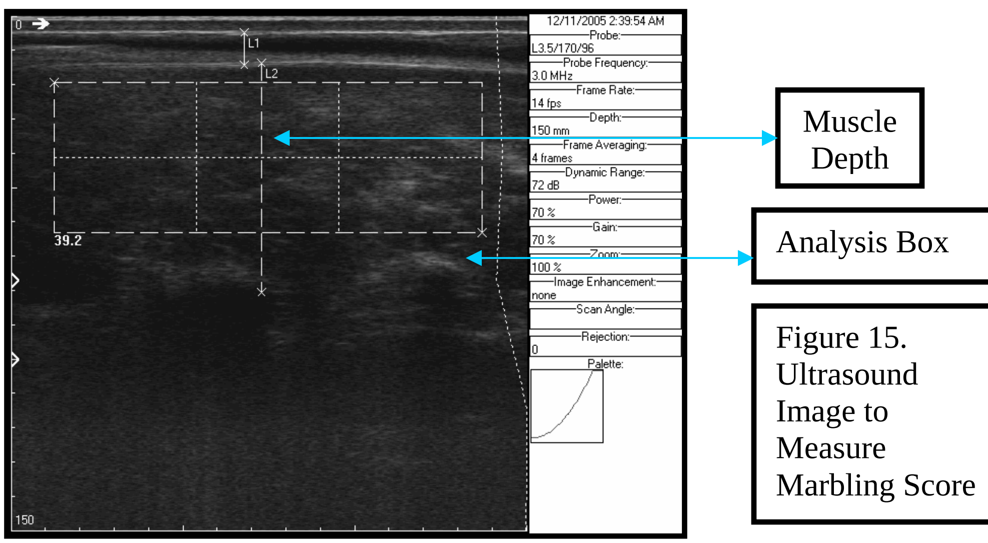


Figure 15. Ultrasound Image to Measure Marbling Score

Rump Fat Measurement

Another area of interest is the determination of rump fat, also known as the P8 measurement in Australia. The rump site can be approximated as equidistant between the hooks (tuber coxae) and pins (tuber ischii) of the animal (Fig. 16). Site preparation would be the same as described for cross-sectional scanning.

Figure 16. Illustration of rump fat scanning site on live animal.

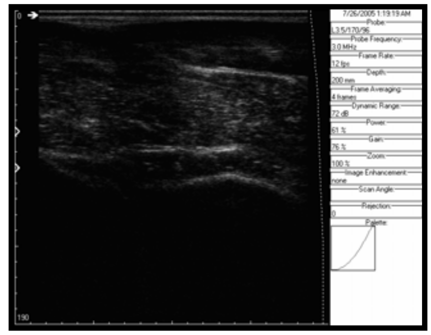


Figure 17. Typical image for rump fat estimation with reference points identified.

However, it may not be necessary to use the acoustical contact curved pad. An image similar to Figure 17 should be obtained. Distance measurement would utilize the same technique as described for backfat scanning. The common anatomical point of reference is the intersection of the tissue line at the bottom of the *gluteus medius* muscle and the bottom of the subcutaneous fat layer. This measurement is especially useful in estimating fat in very young cattle (less than one year of age).

SUMMARY

Real-time ultrasonography continues to be the most advanced and safest technology available for estimating composition and quality of live beef cattle. The Televet 1000 offers an accurate computer-based ultrasound for a variety of uses. It is inexpensive, accurate and highly repeatable for all criteria that may be used to describe the needs of the livestock industry in any part of the world.

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