How ultrasound has revolutionised reproduction management

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In Europe, and increasingly also in North America, ultrasonography – for which the term 'scanning' is commonly used – has been implemented on swine production units. This technique can be ideally performed through the skin, usually of the abdomen (which is then called 'transabdominal' or 'transcutaneous'), without the need to penetrate the animal via the rectum, as is commonly the case in horses or cattle.

The main purpose for scanning pigs is to test for pregnancy. Indeed, scanning is superior to other methods of pregnancy diagnosis. The main advantage is that, even with relatively simple scan units, it allows for early use (starting day 20/21 after breeding; Fig. 2A), combined with its accuracy at even this early stage of pregnancy (close to 100%).

Besides 'normal' pregnancy, failures of pregnancy can also be diagnosed. For example, dead embryos or foetuses can be diagnosed on the basis of missing heart beats or missing blood flow through umbilical blood vessels (the latter can only be determined by using Doppler ultrasonography; Fig. 2B).

Also, situations of embryonic mortality or abortions have been well described by ultrasonography and can be unambiguously diagnosed.

Previously, the main disadvantage of using ultrasonography on farms was the relatively high price of the machines together with a high weight which limited portability and made scanning, especially of loose-housed pigs, almost impossible.

Over recent years, prices have dropped dramatically while 'quality factors' such as resolution and portability improved, and 'good' machines are currently available for a reasonable cost.

One among 'good' machines is the HS 1600 (Fig. 1 with inserted picture) which is a hand-held unit with a smooth and thus easy to disinfect surface. Another advantage is the absence of a ventilation fan which prevents potential spread of porcine pathogens into the surrounding environment.

However, scanning offers more than merely testing for pregnancy. With ultrasonography, both the non-pregnant uterus and the ovaries can be visualised. Imagine the many situations when you wanted to have a look inside the animal but failed for obvious reasons. Using ultrasound, gilts and sows are now virtually transparent! Besides pregnancy testing, this unique form of ultrasound can be used for multiple purposes in breeding pig facilities. Those purposes are:

Fig. 1. Procedure of transabdominal ultrasonography of pigs. A transducer (sector, convex or micro-convex preferred, but linear principally possible too) is placed horizontally just above the last pair of teats onto the ventral right abdomen. Inserted picture: A HS 1600 (Honda Electronics Ltd, Tokyo, Japan) is a 'good' choice for an ultrasound machine to be used on pig farms due, at least in part, to its portability, easy-to-handle settings, a surface that can be disinfected, a good resolution and a reasonable price.

Checking ovulation

The ovary and all the ovarian structures that appear around ovulation are well described. Even after completion of ovulation, when all pre-ovulatory follicles (Fig. 2C) have been ovulated, the ovary can be clearly identified on the basis of the presence of corpora haemorrhagica (Fig. 2D).

This allows for checking when ovulation occurs in individuals and in groups of breeding sows. Scanning to check for ovulation is useful whenever there are questions relating to the breeding management and timing of insemination in particular.

'Checking for ovulation' is also a central element in diagnostic troubleshooting processes of many cases of failure in reproduction.

Checking puberty status

As the pig matures sexually and changes from the pre-pubertal to the pubertal stage, there is uterine growth and the gilts commence their cycling activity, with the first ovulation and subsequent development of corpora lutea or 'yellow bodies' in the ovary.

Scanning allows for the visualisation of the

Continued on page 8

Continued from page 7
uterus and the ovaries in both the pre-pubertal and the pubertal gilt and the assessment of both organs can give valuable information on sexual maturity.

If the ovary is scanned, animals having only small follicles are considered pre-pubertal, while those having large, pre-ovulatory follicles or ovarian structures indicating completed ovulation (corpora lutea) are pubertal. Scanning the ovary as an 'indicator' for puberty status has proven to give 100% accuracy.

If the uterus is used for assessment, the uterine size has proven to be almost reliable as the ovary in the assessment of puberty. In order to make this assessment, the uterus has to be imaged as a cross-section, then measured in two dimensions and the cross-sectional area calculated. Pre-pubertal gilts have a cross-sectional area of ≤1cm^2, while it is ≥1.2cm^2 in pubertal animals (this translate to diameters of roughly ≤0.9 and ≥1.1cm, respectively).

Maximum accuracy in the assessment of puberty status is, however, achieved if both the uterus and the ovaries are scanned.

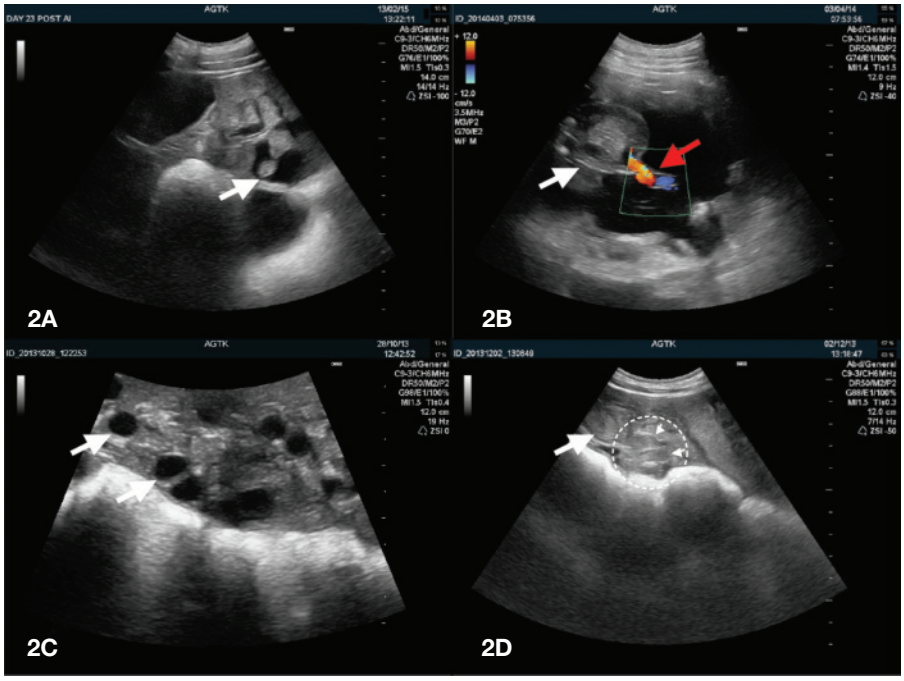

Fig. 2A. Image obtained from a gravid pig showing an example of uterine cross-sections containing embryonic fluid and the embryo itself (white arrow) on day 23 after breeding. Fig. 2B. Cross-section of a gravid uterus with a foetus (white arrow) on day 66 of pregnancy. Coloured signals are from blood flow within blood vessels of the umbilical cord demonstrating viability of the respective foetus (red arrow). Fig. 2C. An ovary with several large (approximately 6mm) follicles (white arrows) 'ready' for ovulation. Fig. 2D. An image from an animal immediately after ovulation. One cross-section of the uterus is marked (white arrow). Next to it is an ovary bearing several corpora haemmorhagica (little white arrows) located within the area circled with a dotted line.

Examination of females with reduced or complete cessation of fertility

If a female displays reduced fertility or absence of fertility, this can be for different reasons. Scanning is directly helpful if the reason is the female herself, with defects related to the ovaries and/or the uterus.

The oviduct is yet not assessable in the pig. Ovarian cysts are usually considered one main reason for the animals' failure to breed.

However, it is only polycystic ovarian degeneration (POD), where the ovary has only cystic ovarian structures, which is fatal to fertility, while single or multiple cysts accompanied by 'normal' ovarian structures are more frequent but of lesser significance.

Cysts (in terms of number and 'quality') can indeed be identified using ultrasonography (Figs. 3A and 3B) and females with POD quickly culled, thereby reducing the number of non-productive days.

Amongst females exhibiting fertility problems, many have uterine infections such as inflammation of the endometrium or lining of the uterus. Although the chronic inflammation is more prevalent, the acute type can sometimes be observed combined with a purulent vaginal discharge. Unfortunately, scanning allows only for the detection of acute endometritis, and recognition usually occurs on the basis of abnormal flocculent or clotted fluid within the uterus.

The echotexture is another parameter used to describe the appearance of the uterus in ultrasound images and uses the distribution and frequency of lighter and darker areas for description.

The echotexture can be described as homogeneous (Fig. 4A) or heterogeneous (Fig. 4B) and undergoes normal physiological changes during the oestrus cycle. It is heterogeneous when females approach or are in heat and larger follicles are present, and homogeneous at any other stages of the oestrus cycle, for example when corpora lutea are present.

Any deviation from the physiologically normal status might be considered abnormal and is associated with reduced fertility. A third parameter, uterine size, might also be helpful in assessment of whether a uterus is functioning normally or not.

The size is determined as described for gilts and is given as the sectional area. Uterine size has been shown to correlate

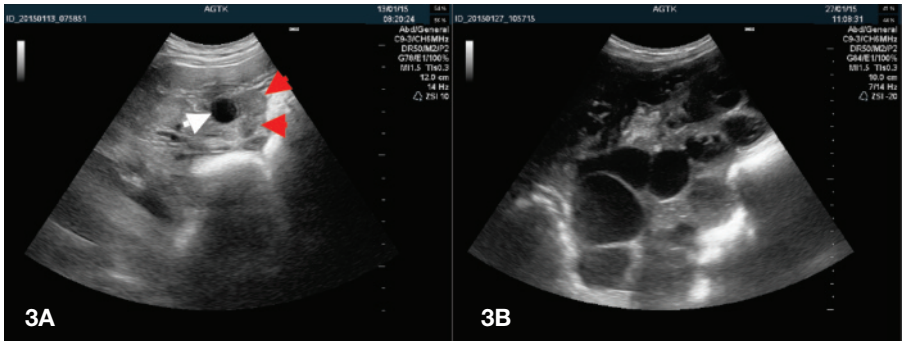

Fig. 3A. Image obtained from an ovary of a non-gravid pig with a single ovarian cyst (white arrow) surrounded by several corpora lutea (two are marked with red arrows). This condition does not have consequences for fertility. Fig 3B. Polycystic ovarian degeneration. There are only cysts (black 'holes'), i.e. no 'normal' ovarian bodies such as corpora lutea in addition. This condition usually leads to life-long infertility and is a reason for an immediate culling.

with uterine weight and the weight itself helpful in the diagnosis of uterine disorders.

For instance, the mould toxin zearalenone, which can cause reproductive problems in pigs, has been associated with very small (light) and very heavy reproductive tracts. Finally, uterine perfusion (i.e. blood supply) has been advocated as another useful parameter in combination with i.e. echotexture in the assessment of uterine functionality and health, and studies are currently ongoing to test this usefulness.

Practical use of ultrasonography

With its multipurpose usage potential, ultrasonography can be much more than merely a procedure to test for pregnancy. Given that pregnancy diagnosis may be performed on day 20 or 21 after breeding, non-pregnant females can be detected right at the time they are presumed to return to service, so they can be subjected to very close heat detection supervision.

The concurrent assessment of the ovaries and the uterus in these non-pregnant females gives additional benefit. As mentioned before, animals with POD can be culled immediately.

However, as a number of non-pregnant animals will have corpora lutea or small follicles, producers might be willing to treat them hormonally to induce oestrus and/or ovulation.

Finally, animals with obvious uterine alterations, such as abnormal intrauterine fluid or atypical echotexture and thus reduced fertility, can be quickly sent to slaughter.

This entire procedure, in combination with routine pregnancy testing, including ovarian as well as uterine diagnosis, will certainly increase productivity through the reduction of non-productive days.

Besides individual pig scanning, and thus more importantly, is the use of ultrasonography strategically in cases of reproduction trouble-shooting. The list of 'troubles' where ultrasonography can be 'valuable' is long and includes:

- Low conception rate.
- Low farrowing rate.
- Low litter size.
- Long wean-oestrus-interval.
- High number of sows with no-heat after weaning.
- High number of returns.
- Late fall-outs.
- Abortion.
- High number of gilts with delayed or no attainment of puberty.
- Discharge syndrome in both sows and gilt.

In addition, using ultrasonography it is possible to assess the urinary bladder, an organ that is very often 'affected' (such as due to sediment which, if present moderately or heavily, is associated with an increased incidence of urinary tract infection). Also, first attempts have been made to test if ultrasonography can provide value to the assessment of functionality and health of the mammary gland, and results are looking promising.

Any of the aforementioned problems would require a separate 'problem-adapted' approach of diagnosis. However, there are 'common' elements' that many problems share; for instance, in case of low conception and farrowing rates, but also low litter size.

In all these cases it would make absolute sense to start the diagnostic procedure with checking ovulation times in an example population, to make sure that insemination times were accurate.

Another good example for using ultrasonography in 'first place' is long wean-oestrus-interval or no heat after weaning.

For example, sows may suffer from anoestrus after weaning due to high ambient temperature in summer or as part of 'second litter syndrome' as the result of metabolic insufficiency, and then will have inactive ovaries as can be clearly seen by ultrasonography.

In contrast, in several cases where no heat after weaning has been reported, heat checking procedures were finally identified as the 'problem', based on the results of scanning demonstrating either large pre-ovulatory follicles or completed ovulation.

Finally, lactational oestrus has emerged as a 'big problem' globally, and is also characterised by animals that do not come in heat after weaning at the expected time within seven days post weaning.

When scanned, those animals will however have corpora lutea, and it is thus logical that they cannot cycle due to progesterone-mediated inhibition of cyclic activity.

However, based on the 'knowledge' of the presence of corpora lutea, strategic hormonal protocols may then be developed specifically for each farm to properly handle this phenomenon (for instance by using the prostaglandin F2 analogue Clospresenol; Planate).

Another good example for the value of ultrasonography in pig production are situations when changes to the reproduction management are planned that may potentially have an effect on the 'reproduction behaviour' in the herd population. ■

Fig. 4A. Image obtained from a non-gravid pig showing an example of uterine cross-sections (white arrows) with completely homogeneous echotexture (uniformly 'grey'). Fig. 4B. From a non-gravid pig showing an example of uterine cross-sections (white arrows) with heterogeneous echotexture ('black' areas or less 'grey' areas within the cross-sections). A heterogeneous echotexture always 'belongs' to follicles capable of producing sufficient amounts of oestrogens (such as medium of large pre-ovulatory follicles). In cases where for example corpora lutea are present, a hetero-geneous echotexture is considered a sign of uterine disease.