

SUSTAINABILITY OF THE KUNEKUNE AS A BREED IN THE 21ST CENTURY

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I was asked to produce an independent report on the sustainability of the KuneKune (KK) pig in the UK and to explain the feasibility of incorporating the use of genetic analysis of inherited traits as a tool in their future.

GENERAL BREED OVERVIEW

The KK breed has found a niche in the UK as an easily maintained, inexpensive, even tempered small breed of pig. This has made the KK the perfect porcine for the pet pig market. The pigs grow a known size and there are many colour variations available to suit all palates; indeed this is a unique market that the BKKPS needs to preserve.

However, due to the relative longevity of pigs, the quantities of KK being bred and the introduction of the so-called 'micropig'; the numbers of customers has potentially reached a plateau. I also believe that the ability to register almost any gilt in a litter as a breeding pig will have influenced quality and / or reduced the requirement for hobbyists to buy decent breeding sows; this is evident by the quantity of older pigs advertised as free to a good home. The flux of older pet pigs available also free to a good home has no doubt contributed to this. To keep breeding at the current or increased levels for the current market and to be sustainable then exploration of other latent attributes of the KK as a breed need to be explored. The use of the KK as a smallholder meat pig is not a foreign concept, and in my opinion the logical next step, indeed a few smallholders and even the odd commercial farmer have seen an opportunity to use the attributes of the KK to assist in improving taste and / or driving up profit in the meat world. Commercial farmers never do anything that would jeopardise a profit and so there is already documented evidence of KK being used successfully in the meat industry.

The second part of my remit inter-twines considerably with the sustainability aspect of the KK. There are perceived issues with previous and current inter-breeding (voluntary or forced due to a limited gene pool) and the associated inherited conditions, traits and deformities. However no data has been recorded and without capture then no statistical analysis on populations can even be estimated. Is there actually a problem with certain inherited characteristics or not? As each inherited trait would have to be explored individually then they need identifying first. Also bear in mind that some deformities can happen spontaneously and just 'one of those things', in my own herd I have seen in 15 years one twisted snout, one scrotal hernia, one pityriasis rosea, and one litter of ten with two splay leg piglets with tremors, all of which I believe were spontaneous. I also have in more numerous numbers bad colour markings that we have traced to one sow bloodline in combination with one boar line which I believe was recessively inherited.

BREED STANDARD AND LINKED SUSTAINABILITY AS A MEAT PIG

Historically there are no recorded data officially recording the original breed standard of the KK. Breed standards can of course be defined at any point in time but care must be taken that the standard is not narrowed so much that the genetic variation is substantially reduced and then rapidly becomes a pressing issue due to the ever reducing gene pool available. There is a wide range of KK phenotypes (visual appearance) tall / short (24 to 30" at the shoulder), long, wide, with/out piri's, range of colours and markings, hair type etc. that all currently meet the 2010 Breed Standard.

Without a historical breed standard then no-one individual breeder can be right or wrong on what criteria the KK should meet as a pig. Their popularity as a 'pet' pig has possibly made breeders lean towards smaller and smaller pigs than the original smallholder pigs that they were. Breeders will obviously favour the phenotypes they have been breeding and logically will lean towards their type of pig. This does not seem to

have been at the expense of average litter size which is good for sustainability and the promotion of alternative uses for the KK breed. What the KK pig should look like is solely based upon the decided Breed Standards and this needs to be decided upon by experts within the breed and where you see the pig going in the future.

Personally I hate the 'modernisation' of pig breeds, commercial pigs do that admirably already, I think traditional breeds should be kept true to type. Are there any old pictures / drawings that could be referred to in helping the design of a Breed Standard?

From a sustainability point of view if keeping the current breed standards (and it is only a view)

- (i) Keep the current breed standard for registerable breeding pigs and use the current or a modified points system to define what pig meets the current breed standard.
- (ii) Allow only a maximum of one boar and two gilts to be BREED registered from each litter with derogation allowed in exceptional circumstances upon inspection or agreement with Breed Reps.
- (iii) Firm up the criteria for a pet pig as below a certain number of points. Perhaps all identified carrier pigs of certain traits could be put in this category (see later) as this will slowly but effectively eliminate them from the PEDIGREE breeding population.
- (iv) Consider giving significant financial savings for pigs chosen for pet registration/ fattening options as an incentive.
- (v) Garner knowledge on how a graded registration process would impact on the current registered breeders?
- (vi) Breed reps and sector reps would be required to monitor standards and help new breeders on the points based system (if adopted) individually or making a training course mandatory before being able to BREED register a pig.

The sustainability of the KK as a breed can depend largely upon how you define a breed standard and you have a unique scoring system (which should be adopted by the BPA in my opinion) that could be used to good effect in the decision making process. As KK have a broad definition of what is the breed then the pigs could be defined as breeding or pet/fattening, making breeders and people start to think like they are a smallholder pig.

An example of the fate of a birth notified piglet

<p>EACH PIGLET BORN has three routes after the birth notification of a litter.</p> <p>Birth notification fee £0</p>	<p>OPTION 1</p> <p>Breed Standard met in full on your points based system.</p> <p>Score of xx and above only eligible for breed registration</p>	<p>REGISTERED PEDIGREE BREEDING PIG</p> <p>Progeny eligible for herd-book, breeding show classes and pedigree meat certificate at end of working life.</p> <p>Pig Reg fee:£20</p>
	<p>OPTION 2</p> <p>Breed standard score of xx and below.</p> <p>All males for pets must be castrated.</p> <p>All pigs with permanent deformities must be for fattening only</p>	<p>REGISTERED PEDIGREE PET PIG</p> <p>Progeny cannot enter herd book but still eligible for pet showing classes and pedigree meat certificate</p> <p>Pet Reg fee £3</p>
		<p>PEDIGREE MEAT PIG</p> <p>Fattening pig only eligible for Pedigree Meat Certificate</p> <p>PMC Fee: £0</p> <p>If subsequently pet registered £5</p>

The points system could be weighted to give more points to the most desirable qualities and even negative values to the most undesirable – those qualities must be chosen by consensus of opinion within the BKKPS.

THE KK AS A SMALLHOLDER MEAT PIG

I am in no doubt that this is a key sustainability option. Failure to create an additional outlet will see a rise in KK for rehome or at markets / rescue centres and a decrease in quality and price for registered breeding stock. Promotion as a meat pig would open up the KK to the same market as the other breeds kept in the UK and this repetitive market each year.

There is an absolute need to take away the preconception that you would be eating a pet and promote the FACT that KK can be every bit a working smallholder pig as the other breeds. I am reliably informed that the sausages are remarkable and if eaten young enough the pork is not as fatty as one would be led to believe. Additionally the KK market for making charcuterie needs through investigation. The Mangalitza aka the lard pig is slow to mature and an excellent salami producer for the very same reason, the quantity of fat.

Promotion of the KK as a meat pig can be performed in various ways

- (i) Introduction of pedigree meat certificates which for breeders of meat pigs should be a free process. As BKKPS membership is £14 per year compared to BPA minimum of £60 (for 2 pigs) this is a terrific saving.
- (ii) Actively participating into National Sausage / meat competitions / blind taste tests etc. to break any prejudiced ideas that KK meat is not as good as a “proper pig”.

- (iii) Promotion in the smallholder press and on forums. Articles on KK as a meat pig (Prac pig Summer 2014). Tap up other piggy authors such as Liz Shankland to write a piece in Country Smallholding. This has already started even in the commercial Pig World magazine.
- (iv) Consider approaching charcutiers (I know Marc-Frederic if that helps) and consider the BKKPS buying and then donating a carcase or two for them to experiment with. The promise of an article in PP should be enough to persuade them.
- (v) Make them 'well-known' for a particular type of product. MG have charcuterie, BK and MW are known for pork, LB for bacon, BS and GOS as dual purpose etc. KK the sausage pig? KK the easy to manage Charcuterie pig?
- (vi) Promotion of their alleged amazing Feed Conversion Rates – A formal calculation for comparative use would be a significant advantage in convincing people they are a valid smallholder pig; price per kilo to produce is a directly comparable unit of measure. Followed by quantification of age you get the most 'bang for your buck' e.g. Middle Whites are sent off at a younger age than some other traditional breeds and up to 90% return as meat is achievable, compared to 73% for a saddleback at a month older.
- (vii) Promotion of boars for hybrid commercial production – approach those using KK boars in a commercial setting for why they use the breed. Ask what types suit them best. What advantage it has given them. Use that valuable information.
- (viii) To compete with other breeds of pig used for meat then the RRP must be considered and be competitive. I remember KK piglets being sold for 3 times the fattening price of other breeds. They need to be of similar price and with OK litter sizes and their lower feed requirements a decent profit can still be achieved.

TESTING PARENTAGE

Testing parentage of an individual pig is possible and numerous companies offer this service. There are numerous applications for this genotypic information such as genetic identification linked to pedigree, parentage analysis, tracing specific animals to finished meat products, pedigree analysis, selection and breeding programs, and animal registration support.

Tissue samples (usually hair) are submitted from parent and progeny and analysed using multiple genes to compare if the progeny are related to each parent. Costs range from £200 to £500 per pig privately but I would have thought this could be reduced substantially if it was a part of a breed registration. Also if one company was used then each breeding pig once tested could have their 'DNA profile' stored and only subsequent progeny need testing.

I would question why you want this information? You could just start taking hair samples from every breeding registration and store them for future testing should there be an issue. The only cost would be the storage which may amount to a freezer or the price of a DNA extraction and storage. The sample is only as accurate as the person collecting it so who will collect the samples and check the identification of the parents?

TRACING MIXED BREEDS

The Food Standards Agency uses DNA analysis to look for the presence of different species in food products, we all remember the horse meat scandal. This type of analysis is too crude to detect different breeds of the same animal i.e. it can tell you if the meat is pork, goat, lamb, horse etc. but not if it is a KK x Berkshire for instance.

However; a paper was published (and reported on in *Practical Pigs* magazine) recently using DNA markers to ascertain the genetic diversity of different pig breeds. Unfortunately it didn't include the KK however it shows that the ability to deduce mixed breeding from the DNA of pigs. The assay was originally developed to be able to prevent food fraud i.e. stating something is one breed to obtain a premium price when in reality it's a hybrid of unknown parentage. The work was performed at the Roslin Institute which has already expressed an interest in the KK breed. PDF of the full paper has been sent with this document or www.ncbi.nlm.nih.gov/pmc/articles/PMC3499217/pdf/1471-2164-13-580.pdf

There are advantages in doing this if you believe breeders have been dishonest in their registrations and you can refuse to register a particular pig based upon the results but bear in mind it may have been the people they purchased their stock from with pigs already in the breeding register and potentially numerous generations would need to be removed.

The disadvantage is yet again what will you do with the information? Removing existing pigs from a register has numerous implications. Would your members be happy with their pigs being moved to a part bred register or removed completely? What would you do with any that have been sold on to other breeders – remove from the register?



REDUCING INHERITED CONDITIONS

Deformity, disease susceptibility, and other undesirable traits e.g. extra cleys can be due to a spontaneous, never to be repeated gene deformity or mutation. These can be by genetic accident and 'just one of those things' or in response to an illness or medication administered during pregnancy. Many of the same deformities and traits can be caused by inherited genes, from either parent, which may be noticed rapidly in certain bloodlines or populations (DOMINANT or X-LINKED GENE) or they may be more insidious and only become apparent as the gene pool narrows (RECESSIVE GENE). Most genetic inheritance traits likely originated from an accidental mutation and just remained to be passed on to the any progeny.

It is no-ones fault and definitely not due to something the breeder did or did not do. Individual pigs in their herd are not substandard through anything other than chance and probability which happens to all breeders of pedigree (and non-pedigree) animals; just in the other UK pig markets they can often fatten those pigs for meat.

The prevalence or incidence of inherited traits in the KK in comparison to more diverse native or modern pig breed populations is undocumented and is therefore anecdotal. It is not documented for the native and modern pedigree breeds either btw. Before any money is spent on reducing inherited conditions there is an absolute need to find out what, if any, there are and at what level of prevalence across the UK, within named bloodlines, within geographical areas, and within certain phenotypes. From this data you can decide if you can go along the non-scientific route and how urgent the problem is, or if you need some extra help in identifying who has what gene.

NON-SCIENTIFIC ROUTE

The problems of any traits becoming established in a population can be delayed or even prevented from becoming a problem by keeping the available breeding gene pool as diverse as possible. This can be done by either importing unrelated female lines or unrelated male lines (live boars or semen - the impact per imported pig is quicker with boars as they can be used on multiple sows) OR using a 'Grading up' system.

The issue with importation of boars or semen (aside from the current worry of importing from the USA and extended Europe regarding PEDv and ASF) is one of bloodlines. Before importation proceeds you will need to know how closely related imported boars are to the stock here in the UK. As I understand it the KK societies in the USA and NZ are keen to harmonise the way the breeding data is captured. This is essential for both non-scientific and scientific approaches to increasing diversity and is a number one priority.

1. Use ancestry databases strategically
 - (i) The use of Zootasy / Grassroots etc. as a way of direct comparative ancestry of the KK in the major breeding countries.
 - (ii) Another type of analysis e.g. Geneped can use that data to calculate how related one pig is to another aka its breeding co-efficient. Typically; the lower the number calculated the less related they are with zero representing not being related and 1 representing 100% related. As I understand it Zootasy may do both but this needs clarification.
 - (iii) Use to calculate breeding co-efficient between bloodlines in the UK
 - (iv) Use to calculate breeding co-efficient between imported boars and sows in the UK
2. Import new boars / semen for public stud

- (i) Use a strategic plan to use on female bloodlines at most genetic risk as a priority
- (ii) Have a timed importation plan – Consider staggering the importation. It is more expensive but potentially more effective.
- (iii) How many to import at a time to significantly lower breeding co-efficient.....?

The 'Grading up' system should only be considered within a strict control of the BKKPS. This is the use of other breeds to input completely different genetics into known KK bloodlines, preferably where less problems of the traits you are trying to eliminate occur. These graded up pigs are held on a sub-register and the progeny only included in the pure breed register when they reach a certain percentage. Although highly effective it is a slow process and would take at least 5 generations in my opinion.

Progeny from first cross between KK and another breed (F1) would be 50%; F1 x 100% KK to make an F2 that would be 75% $((50 + 100) / 2 = 75)$; F3 would be 87.5%; F4 would be 93.75%; F5 would be 96.88%; F6 would be 98.5%; F7 would be 99.25%

Also bear in mind that you could introduce problems that you don't yet have into the KK breed.

It has been used successfully in other pedigree breeds e.g. Middle White and Berkshire, and I could find out more should this route appeal to members. As an aside, there has been an associated issue of snobbery among BPA pedigree breeders regarding these 'made' bloodlines which although not a major problem is interesting to note.

SCIENTIFIC ROUTE

Before considering the scientific route there are a number of factors that require collating or considering.

- (i) Absolute need to determine the prevalence of each inherited condition you wish to eliminate in the population before any genetic analysis can be performed.
- (ii) Additional prevalence or incidence in certain boar lines / sow lines/ combinations would be useful in interpreting any data generated.
- (iii) How will you encourage breeders to divulge the information? Some will put the good of the breed first but others will be intimidated by the stigma attached to revealing breeding faults.
- (iv) Phenotypic data (visual appearance) should also be captured. A trait may be able to be traced back e.g. all black pigs with a ginger dot on their head are genetic carriers of umbilical hernia's for instance.
- (v) Have you considered what you will do with pigs that are gene positive to a particular trait? It is pointless determining which pigs carry particular genes if they are not removed from the BREEDING population.
- (vi) If culling / removal from breeding herd book are to be performed then how would your members feel about this? Will you get co-operation?
- (vii) Future co-operation could be ensured if a hair sample had to be submitted and appropriately stored with each BREEDING registration. However without removal of existing carriers in the breeding herd then the problem will persist.

- (viii) Do you have the full cooperation of the BKKPS members in informing you of defects in their piglets? For each trait you will need to submit samples from a pig with the trait (the cases), their siblings / parents (case-linked controls) and preferably from pigs with no history of the trait in their heritage (case controls) to be able to detect these genes in future pigs.
- (ix) You also need to be aware that if the trait carried on single gene then smaller numbers cases and controls required, however, if carried on multiple genes then large numbers of pigs required. **The actual numbers requiring testing will depend entirely upon estimated prevalence within the UK herd, the number of genes the faulty gene is located upon plus the level of confidence you wish to have in the data, aka Confidence Limits (the higher you want the more samples you need to analyse).**
- (x) The list of inherited traits as determined from other breeds is extensive and some are more common than others in all breeds. The list in the table below is some of the defects detected from a modern cross but from the prevalence data you collate you will be able to work out the most common defective traits in the KK. Some are also more serious than others in severity to the KK breed. This also needs consideration when deciding which traits to eliminate the carriers from the KK population as some may not be considered a problem e.g. no piri vs two piri.

Examples of ‘genetic’ defects that can affect pigs – there are many more!

Tremors	Bent legs
Splay leg	Thickened forelegs
Atresia ani (no anus)	Crooked mandible
Scrotal Hernia	Microtia (stunted ear)
Cryptorchid (retained testicle)	Hydrocephalus
Intersex	Epitheliogenesis imperfecta (incomplete SKIN)
Female genitalia defect	Eye defects
Umbilical hernia	Pityriasis rosea (skin condition)

Assuming all the criteria listed and club member co-operation has been approved and you have decided on which trait(s) you will start with, I would suggest either the most common as less samples are required or the most devastating to the KK breed. The need to comprehend how detection of these genes works and why you would use it, requires some basic genetic understanding of inheritance. I have tried to keep it to an absolute minimum and written as simply as possible.

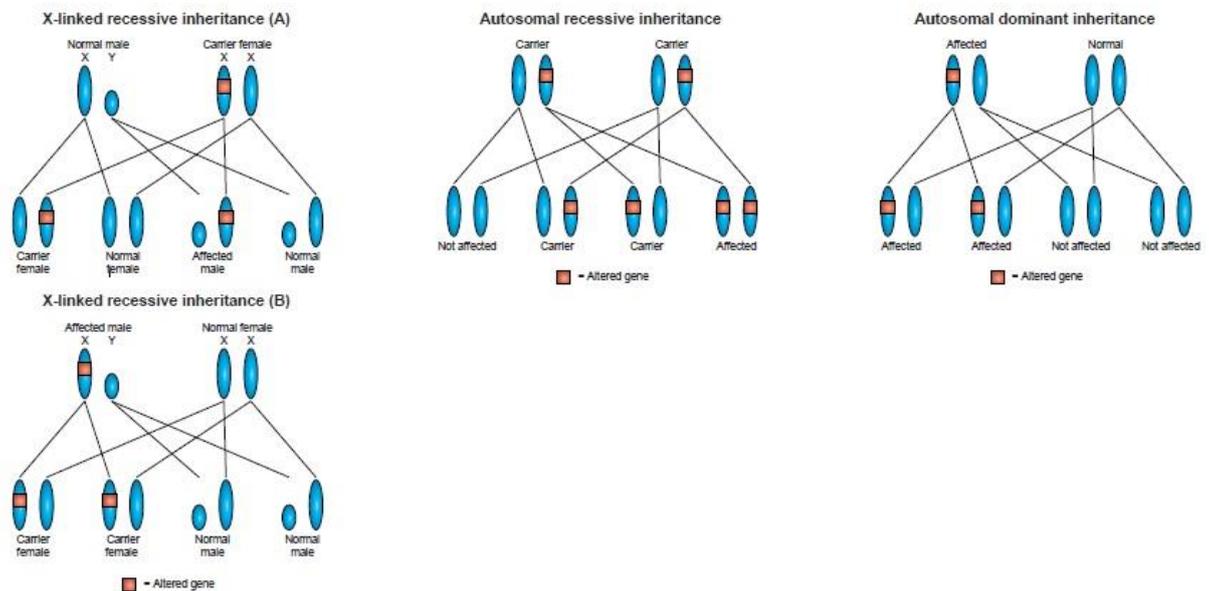
Genes are coded sets of instructions to inform the body on every functioning aspect, from visual appearance to minute cellular instructions. There are thousands of genes within an individual pig and by and large all works well. Each normal gene carries two copies, one donated from each parent and they operate together with one as ‘back up’. When one of the gene pairs is dysfunctional the effect upon the pig will depend upon if it is a dominant gene or a recessive gene.

When it is a dominant gene that is defective, the pig WILL have the undesired trait at some level and depending on the trait the severity may be variable. Of course most breeders do not use a pig with an obvious defect for breeding but it is still happening for unseen conditions e.g. heart murmur, diabetes, enzyme deficiencies etc. There is a minimum 50% chance for each piglet born (either sex)

to have the same trait, higher if both parents have the dominant defective gene and so high numbers would be observed in a breeding population.

When it is a recessive gene that is defective, the pig MAY have the trait or MAY be a carrier of it. Carriers are perfectly healthy as the correct version of the gene is being used but they carry a copy of the defective gene as the 'back up' copy that may arise in subsequent progeny if they are mated with another pig that also carries the same defective gene. Then, each piglet has a 25% chance of not having the gene, a 50% chance of being a carrier of the gene and a 25% chance of exhibiting the trait. If the carrier was mated with a pig without the defective gene then each piglet has a 50% chance of being normal and a 50% chance of being a carrier – but 100% would look outwardly healthy and would be free of the particular trait. The trait ONLY appears when two carriers are mated together or one carrier and one pig with the trait. Another factor to consider here is the slow build-up of carrier overtime before a trait is physically present; a figure of 20% of pigs within the total population being a carrier of a trait isn't unrealistic. Also this will be entirely skewed data and much higher levels in some herds will exist and conversely other herds will not have the trait.

To confuse the matter a little more; genes are donated in groups with other genes and if the defective gene is transferred with the same gene that determines the piglets sex, it is known as sex linked or X-linked. Gilts always have two copies of the X sex gene (XX) and boar piglets always have one X from the mother and a Y from its father (XY). Typically defective genes are carried along with the X gene so if the piglet is female it has a 50% chance that she will be a carrier, if the piglet is a boar then there is a 50% he will have the trait. If a boar with an X linked condition is used for breeding (with a normal female) then all female piglets will inherit the defective gene but all the boars would be normal. If the boar has the x-linked trait and the sow is a carrier then there is a 50% chance of each piglet of either sex having the trait and 50% chance they will be a carrier if female; and a 50% chance of being free of the gene if a boar. If both parents have the X-linked traits then 100% of the piglets will inherit it.



The hardest to determine in a population are the recessive inherited traits and this is the inheritance that Ridgene has been designed to detect. However; Ridgene only identifies the causative gene of the SINGLE trait you are looking for and enables other pigs to be tested for the presence or absence of only that gene. 'To actually 'rid' the gene from the KK population you have to act pro-actively on the results of the pigs tested'

Genetic study applications

- (i) Any imported boars could be checked for the trait(s) before importation.
- (ii) Zooeasy / Grassroots databases could be used to analyse the potential of carrier spread in existing breeding pigs that have the same ancestry as the case and linked controls. It may with enough data be possible to identify when the trait entered the population.
- (iii) Ditto on breeding co-efficient data if available.
- (iv) It may be that it is an obvious bloodline(s) that is the cause of the trait and strategic importation may assist in ridding of the gene. Or the trait is a clustered event in small populations and new boar importation isn't required, yet.
- (v) The Roslin institute has expressed an interest in identifying single trait(s) using 'Ridgene' once criteria have been satisfied at a reduced cost of circa £100 per pig. How many cases required for a trait carried on a single gene is lower than if carried on multiple genes (different genes when defective can produce a similar phenotypic trait) and so more case analysis will be required. **The number of cases for EACH trait depends upon the calculated prevalence in the KK population, the number of genes that could carry that trait and the level of confidence you want in the data. Do you even have enough CASES in the KK population?**
- (vi) The cost of £100 per pig is just to identify the gene responsible for that particular trait. Once the gene for each single trait is identified further expense will be required to test pigs for the presence or absence of the identified gene – a policy will need to be drawn up as to who will pay for what pigs to be tested.

So before you decide to proceed and potentially spend £000's what will your policy be if a recessive gene is determined in the KK will you;

- (i) Forcibly cull or de-breed register all carriers who otherwise look healthy and only have a problem when mated with another carrier? If pet registrations were separated from the main breed registration then these would be an ideal category to put carriers in and actively avoid culling.
- (ii) Consider putting sows in a 'vulnerable register' and provide non-carrier boars? But then what will you do with the 50% of carrier piglets in a litter? Force them to be pet registered / castrated if boars? You will also have to potentially test every piglet in every associated litter born!
- (iii) Culling or castrating positive breeding boars are the only sensible options to rid of the trait and so all registered boars would require testing.

If you won't be taking any action on gene positive pigs then there is little point in paying for the testing capability to do so.

SUMMARY OF WHAT NEEDS PERFORMING IN THE FIRST INSTANCE

1. Increasing the 'seriousness' that the KK is taken as a viable meat pig – promote a niche market
2. Implementation of a compatible database of KK ancestry with other world-wide breeders
3. Revision of the criteria of registered breeding pigs
4. Determine the prevalence of existing undesirable traits in various populations and phenotypes
5. Decide on policy of what you would do with the scientific route results obtained should they prove undesirable.

Only then can you move forwards and select the appropriate non-scientific or scientific approaches to improving the breed further. Also in the knowledge that the club funds have been used to create a 'protocol of best practice' in the improvement of the KK breed.

To ensure the report is independent I have asked questions of some BKKPS committee members without explaining why I need to know the information and have been provided with public KK material such as newsletters, the Ridgene protocol, and other statistics produced when the last KK pigs were imported into the UK. I have also accessed the public BKKPS website. Although those that know me will be fully aware that I speak directly and cannot be 'lent on' to go against what I believe is true, no attempt has been made to influence what I have written. Some of the report may be highly disagreeable to all/some BKKPS members and the adoption of any part of this report in to your due process is yours alone to make and outside of my role. I do not and have never owned or bred a KK pig and so I have no preconceived ideas or gain in how the KK as a breed should progress. I have responded to the task given using my knowledge of pigs in general, the public data provided and my professional expertise in the field of livestock genetics.