# Whittemore's Science and Practice *of* Pig Production

THIRD EDITION

**Ilias Kyriazakis**
*BVet Med, MSc, PhD, MRCVS*

**Colin T. Whittemore**
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# Contents

# Preface and Acknowledgements

The first edition of *The Science and Practice of Pig Production* was by far the most extensive book that I had written. It was the result of a challenge that I should prepare a book of adequate scale and breadth to deal comprehensively with the whole international spectrum of the science and practice of pig production. The temptation to gather a consortium of authors and edit a multi-author title was resisted. I wanted this book to have cohesion and purpose, and to demonstrate an integrated philosophy. I wished to take the reader through the subject, examining the knowledge offered from a perspective that, although multi-dimensional, nevertheless sprang from a coherent and individual source. This could only be done by single authorship.

The second edition of the book had substantive additions, a good number of alterations and a few deletions. The opportunity to update had been timely, as much has happened in pig production and science since the first edition was written, but perhaps especially in biotechnology, meat and carcass quality, the understanding of growth, animal welfare, genetic improvement, disease and health, and some aspects of feeding and nutrition. Interestingly, the same subjects tend to figure in the major updates of this third edition.

For the third edition I decided that I could no longer support the contention that a single author could cover the scope of this book, and so a panel of international authorities was invited to join me in revising the text. In order to maintain the cohesion of a single text, and keep faith with the original principles of the book, I decided that the book should have a senior editor (Ilias Kyriazakis). The recognition given to all those who have contributed to the third edition is detailed on the Contributors page. I would like to acknowledge here the support and efforts of Professor Kyriazakis and the new contributors.

Although it remains the case that much of the work in the body of this book was completed over more than 30 years of research at Edinburgh, the new text now contains substantial bodies of information from other international centres, and this is recognised by the new panel of authors. One author cannot possibly have complete knowledge in breadth and in depth. For all of us, this dilemma can only be solved through learning from others and benefiting from their counsel, and this we have all done over many years of production and industry practice, university learning, scientific research and consultancy. We are pleased to be able to acknowledge formally the great debt we owe to all those from whom we have accumulated information, knowledge and wisdom.

The precious resource of input from the named authors, and all those around them, has nonetheless been subject to interpretation and to filtration. Such is the consequence of editing a large book. The editors, therefore, but especially myself, must bear responsibility for the final content.

*Colin Whittemore*
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Chapter 1

# Introduction

The prime agricultural purpose of the pig is to provide human food (fresh, cured or processed), so pig production is necessarily preoccupied with the quality of the pig meat and the efficiency of its production. The pig grows rapidly, reproduces at a high rate and is accommodating in its eating habits. Historically, the pig was often seen as a scavenger; a rural scavenger in fields and woodlands, and an urban one using human food by-products and waste. These roles have ensured that the pig has been used as a domesticated agricultural animal widely throughout the world, but usually in small population sizes such as would facilitate by-product utilisation and encourage simple husbandry practices.

Recent history has seen the demand for high-quality pig meat products rise world-wide due to the increasing world population and improving human nutritional aspirations. This has raised the profile of the growth and reproductive characteristics of the pig. Simultaneously, improvements in other branches of agricultural practice have made available substantial quantities of cereal, legume and oilseed grains not appropriate – or not needed – for human consumption. The industrialisation of human food preparation has added to the changing environment by moving the availability of food by-products and waste away from the local and diversified domestic level and toward centralised manufacturing points. There has been a change in the nature and objectives of pig production over recent decades. Especially there has been created a large-scale integrated agricultural industry, producing substantial quantities of high-quality meat products which may be readily traded within and across international boundaries. The agricultural and biological sciences have been well set to serve pig production over its recent evolution, and the result has been a staggering example of the successful application of science to industry to the benefit of humankind. The modern pig industry bears little or no resemblance to that of only a few decades ago; either in its structure or in its method of trading, or in its definitions of quality in the end-product, or in its breeding, feeding, housing, health and management.

The major changes are often perceived in terms of sophistication and scale; and associated with the latter, intensification. Coping with these changes has demanded of science – and science has provided – new husbandry practices, new understandings of growth, reproduction and health, new appreciations of welfare and the environment, new nutritional approaches, and modern genetic improvement techniques. However, above all has been the essential placing of the application of science in

the context of latter-day production and marketing. Biological response is interpreted in terms of not only physical outcomes but also financial consequences.

Numerous small herds (<100) of breeding sows abounded as recently as two decades ago, but the major activities of pig meat production have now come to lie with the big integrators, often backed by corporate money, and where breeding, production, marketing, processing and consumer sales are closely coordinated. It is difficult to achieve efficiency of modern intensive pig production with unit sizes of less than 250 breeding sows, while 500+ would be unexceptional. Some of the larger operations will have a number of standard-built units spread about a locality, and managed from a central company headquarters (as, for example, in the US Carolinas). North America, originally the home of the family-sized hogg farm, now leads the big operators, with many companies having more than 10 000 breeding sows and a significant number more than 100 000. This pattern is followed now in Spain (where two companies each have around 100 000 sows and each grow for slaughter 2 million or so meat pigs annually), Italy and Asia; while in the other European countries many pig producers remain individual owner-managers, albeit with units of 200–5000 sows.

While trends in pig production have had some degree of commonality worldwide, there remains diversity in international production practice and end-product objectives. Thus, although a high proportion of the sciences cognate to pig production are transferable across national barriers, the *way* the scientific information is used may need to vary widely. The most useful aspects of the scientific information base are those that address basic causes of biological and economic response, and *not* those that lay out the responses themselves in the form of rules and recommendations.

Throughout, the book argues causality and logic before presenting outcomes, and tries to avoid the bald presentation of the results of this or that production investigation as if the latter were to embody some form of universal truth; which of course it would not. It is fundamental to an international text that along with the description of phenomena must go their understanding. Universality lies in the depth of the understanding of biological and economic processes, not necessarily in the accuracy of their description. Nevertheless, pig production is a quantitative as well as a qualitative activity. Meat of given quantity and definable characteristic requires to be produced from feedstuffs of quantifiable nutritional value when given to specific pig genotypes in describable environmental, managemental and economic circumstances. Where possible, therefore, factors impinging upon the production process are expressed in hard and quantifiable terms. After all, it is only through quantification that the absolute and relative importances of the various aspects of the sciences and practice of pig production can be compared, judged and ultimately used.

The world's pig industry is a success story founded in the application of science to management. The extent of the success thus far is well illustrated in Figures 1.1 and 1.2. However, there is no reason for complacency, and a great deal more can be done to improve the level of efficiency of output and the quality of the end-product.

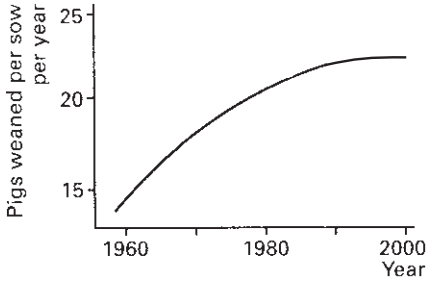


**Fig. 1.1** Rate of increase in sow productivity (northern European data).

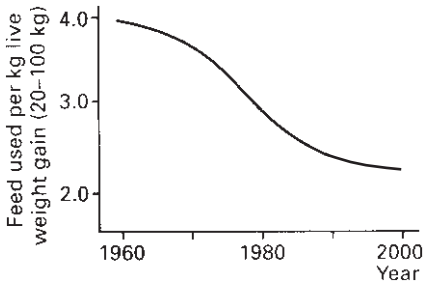


**Fig. 1.2** Rate of improvement in feed usage per kilogram live weight gain. The 1970s saw the introduction of high nutrient density diets in significant quantities (northern European data).

Most pig production enterprises world-wide are under-achieving, and there is a considerable disparity in production efficiency between different nations. Compared to the presently known potential, the world's pig industry falls far short. Application of scientific principles and sound production practices can redress that short-fall.

Chapter 2

# Pig Meat and Carcass Quality

## Introduction

World pigmeat production has risen linearly in the latter half of the twentieth century, with some authorities estimating a doubling in output over this time. At present, 50% of pig production is from Asia and the Pacific (one-third of the world's pigs are in China), 30% from Europe and the former USSR, 13% from North America and the remaining 5% from Africa and South America. The world's expansion has taken place almost entirely in Asia and the Pacific (over 300%), expansions in Europe, the former USSR and North America being only around 40% since 1970. The popularity of pig meat differs widely throughout the world. Of all the meat eaten in Scandinavia 60% is pig meat, in the European Community 50%, in Japan 45% and in North America 35%, but in Argentina only 5% of all meat eaten is pig meat. World-wide, pig meat is the most popular of all available meats.

It may be taken for granted that pig meat product must first be *needed* (i.e. there must be a market), and next be safe to eat. It must also be *efficiently produced* (competitively priced) and at the required level of *quality*. However, increasingly meat production must satisfy further criteria in relation to production *method* and production *environment*, which must be both *sustainable* and *ethical*.

Within recent history, the pig has been bred for both supreme fatness (the required commodity being lard) and supreme leanness (the required commodity being muscle). Whether the acceptable pig carcass be fat or lean depends much upon national predilection. As industrialisation develops, the desire for lean meat appears to dominate the definition of carcass quality. Eastern European, Japanese and North and South American tastes are, like Western Europe, demanding progressively lower levels of meat fat content. Asian pigs, numerous in China and the Pacific countries, are overfat by Western standards, and it is likely that some desire to reduce fatness will take place there as well. Nevertheless, one nation's lean pig remains another nation's fat pig.

In Europe, the pig meat market used to be for mass product at low price. Indeed, general advancement of knowledge in pig production has resulted in the real cost of pig meat now being a mere 30% of what it was 40 years ago. There are now 12 000 000 sows in the European Union and 120 000 000 pigs in total. The average European consumption of pig meat per head per year is more than 40 kg. There is substantial cross-border trade in pig products, a trend that will increase if the present export ambitions of some countries (including the USA) come to be realised. In the

UK there are 800 000 sows and 8 000 000 pigs in total. Fifteen million pigs are slaughtered annually, producing some 1 000 000 tonnes of pork, bacon and ham product. Half of the bacon eaten in UK is imported, and about half of that comes from Denmark, with a quarter from the Netherlands and a further quarter from the Irish Republic. The UK exports about the same amount of pork as it imports (100 000 tonnes), but the importation of bacon and ham is some 350 000 tonnes, and there is no effective export trade. The UK public consumes 15 kg per head per year of fresh pork and 7 kg per year of bacon and ham. There is also further consumption of pork through prepared pig meat products. Italy imports substantial quantities of meat products from pigs slaughtered at live weights of below 120 kg but exports substantial quantities of meat products from pigs slaughtered at live weights above 150 kg. Japan has been traditionally supplied from Taiwan, but Denmark and the USA have recently expanded their export business to Japan.

Fat reduction, now readily achievable to its optimum level, was initiated originally not by consumer discrimination against fat but by the economics of pig production and pig processing, both of which benefit from a lean carcass. Pig markets still tend to divide into two types: one uses pig meat as a substrate for a huge variety of manufactured meat products and satisfies a continuing need for low-cost meat; the other, of increasing importance, attends to the consumer supply of pork and bacon meat of high eating quality. This latter market needs carefully prepared cuts, a low level of subcutaneous fat, an adequate level of intramuscular fat and a large mass of lean tissue, giving a high perception of eating pleasure – meat that is juicy, tender and tasty, avoiding all suggestion of dryness, paleness, taint or toughness. It should not be presumed, however, that a demand for lean pig meat is universal. Indeed, the production of lean genotypes for the northern European pig meat consumer can be the cause of a need for remedial action in southern Europe and in Asia, where a much higher level of fat is required – at least for the present.

Producers may be reluctant to accept the restraints imposed on them by a meat trade concerned primarily with product quality. Conversely, the trade may be slow to allow producers to profit from the benefits of new techniques and streamlined production practices. Such problems will remain with an industry which in many countries continues to be based upon adversarial trading and mistrust at each interface of the production chain. The successful future of pig industries the world over is likely to require the benefits of integration between breeder, producer, feed compounder, meat packer and retailer. The producer needs effective lines of communication with the market. If that communication generates information that is useful, both producer and meat trader will profit.

## Marketing

Europe is an example of an industrialised economy with primary agriculture contributing 2–5% of Gross Domestic Product (GDP) and employing 3–8% of the work force. The livestock sector comprises some 50–60% of total farm income. Food and

drink manufacture represents a surprisingly large 10–15% of the manufacturing sector, contributes at least 2% of GDP and employs around 3% of the work force. Twelve percent of overall consumer expenditure is on food, being some 20% of household expenditure. Of the total food expenditure, some 40% comprises meat, dairy products and eggs, of which some one-fifth of the cost can be traced back to the primary product, four-fifths being added value in the manufacturing, processing and retail sectors. Half of the meat purchased by consumers is derived from pigs, and the trend continues to favour pig meat consumption over other meats.

Live pigs are marketed at any time subsequent to weaning (which can be between 6 and 20 kg and at 3–8 weeks of age). Pig meat can come from suckling pig at one extreme, and from 180 kg animals destined for the production of large Italian Parma hams at the other. National consumption patterns cause pigs to be finished and consumed at a wide variety of weights between these extremes. As the mature size of many Asian pig types is so much less than European types, slaughter weights are usually less. In many European countries 50–80 kg live weight is the traditional *butcher* range for the production of small, fresh pork joints bought and consumed locally, while in Japan, Australia, North and South America and all the countries of Europe 90–120 kg live weight is the traditional range for *industrial processing* at meat packing plants which distribute fresh pork joints, cured bacon products and delicatessen lines. Animals used for the production of hams which are dry-cured by slow and natural processes (such as prosciutto in Italy and Serrano in Spain) are usually finished to substantially greater live weights. Cull sows weighing 120–300 kg may command a useful price according to the state of the market. Meat from cull sows can be satisfactorily incorporated into a range of products, and it can be cost-effective to sell culled animals in good body condition when the price is satisfactory. Adult male pigs that have been used for breeding are inappropriate for human consumption, the meat being coarse and often tainted. This criticism does not apply to fast-grown entire males of European breed types slaughtered at less than 110 kg.

Prime meat is usually found at around 30–60% of mature size (Figure 2.1). At less than 30% there is a tendency toward lack of flavour, whilst at greater than 60% there is a tendency toward lack of tenderness. Pig types of larger mature size merit a higher slaughter weight, and it is noticeable that conventional slaughter weights in the European pig industry have been increasing over recent years. Most pigs used for processing and meat packing in industrialised countries have a mature weight

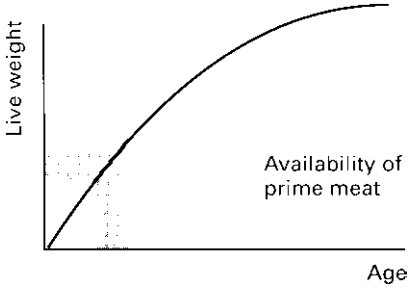


**Fig. 2.1** Prime meat is found from pigs slaughtered at between 30 and 60% of mature size.