KRMIVA

CHALLENGES IN ANIMAL PRODUCTION IN THE 21ST CENTURY

IZAZOVI U PROIZVODNJI ŽIVOTINJA U 21. STOLJEĆU

D. J. A. Cole

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INTRODUCTION

The direction of animal production in the 21st century is dependent on many factors. Some aspects can be determined by predictions based on past trends while others may result from factors not yet identified. There are dangers in projecting forward on the basis of current performance, in that changes are unlikely to be linear and the model on which to base predictions is unknown.

Early production targets were based on the need to optimise or maximise production, for example, food conversion ratio, reproductive efficiency. In meat producing animals, lean content of the carcass was recognised as being important and breeding programmes made efficiency of lean meat production the target. The nutrition needed to sustain these genotypes was usually established some time later.

More recently, other important targets were recognised and Professor Mordenti introduced the ACE principle in animal production. This was to take account of the Animal, Consumer and Environment. However, these considerations should not lose sight of the need to keep the producer in business by giving him financial returns based on the achievement of production targets.

Animal production will need to be based in areas that have access to food, water, labour and technology and preferably close to the consuming public. Such considerations may militate against competitive interests for rural land. In Britain, there has been increasing interest in the role of the countryside for recreational pursuits. Furthermore, the provision of power in various ways from wind farms to crops for ethanol production could reduce the productive land otherwise available for food production.

DEFINING THE PARAMETERS

Historically the measurement of production parameters has been in fairly simple terms defining yield and efficiency, for example, piglets/sow/year, and food conversion efficiency. For some time, Gadd (2003) has suggested, in pig production, that we re-think the terminology that we use and consider profit more than physical production. He calls this 'econometrics', which he defines as the measurement of cost-effectiveness For example, he suggests:

REO (Return on Extra Outlay) is valuable in assessing the response to change. This is better than unit cost or cost/tonne or/animal or/m^2 as it puts product performance and overall cost into perspective.

MTF (Meat/TonneFeed) is a better yardstick than food conversion ratio. It sets the main production cost (food) against income.

WWSY (Weaner Weight/Sow/ Year) is suggested to replace pigs weaned/sow/year. This should be accompanied by an indication of age at weaning.

D. J. A. Cole, Nottingham Nutrition International, United Kingdom.

PREDICTING THE FUTURE FROM KNOWN TRENDS

Predictions are fraught with problems. We can use our intuitive feelings as did IBM executive Thomas Watson when he said 'I think that there is a world market for about five computers'.

The question arises as to how far we can increase the output from an individual animal and whether this is a desirable objective. What is the relationship between maximising and optimising output? While there are many factors that can affect these issues, the first consideration is to establish the ceiling to the animal's performance.

Taking growing pigs as an example, it has been suggested that over the last century daily gain in French Large Whites has increased by about 100% (Tribout et al, 2003). Annual changes in European pigs have been suggested to be an extra 20g/day in growth rate, an extra 0.5% lean meat and 0.2 piglets/litter more (Merks, 2000). For the future, it has been proposed that the annual progress in daily liveweight gain will be 15g/day (Walters 2001). On this basis, performance of the growing pig has been projected forward (Table 1, Wiseman et al 2005). The data relate growth and carcass characteristics to appetite.

Table 1. Projected pig performance (described as genetic potential) (Wiseman et al, 2005).

Year	DLWG (g)	Daily lean growth (g)	Fat P2 (mm)	FCR (kg)	Feed intake
2005	950	431	11.9	2.50	2.37
2010	1025	471	11.3	2.38	2.44
2015	1100	513	10.7	2.28	2.51
2020	1175	554	10.1	2.18	2.57

Predictions from commercial records (MLC, 2003) suggested the following changes over the 45-year period to 2050.

- Growth rate +135 g
- Backfat -1.5mm
- FCR -0.38
- Feed intake +1.6kg/day

A feature of these predictions is that they are linear and biology tells that this is not usually the case. To achieve such responses from the individual animal, large changes would have to be made in its inherent characteristics. In conventional breeding, the selection for larger mature size would help. The introduction of new gene technologies is a possibility with a greater understanding of the genome, gene transfer, gene markers etc. However, Haley and Archibald (2005) suggest that their adoption into commercial breeding programmes is some distance away. Fundamental to achieving greater growth responses will be a greater appetite and intake of nutrients. Failure to do this in selecting for the efficiency of lean meat deposition has, in the past, had implications, not only for the growing pig itself, but also for the breeding sow.

THE CHALLENGES

Feeding the worlds population. Various estimates of population increase exist. A typical projection is that the world population will have increased by about 75% in the next 50 years (estimates of population in 2050 vary from about 7.5 to 10.5 billion). Thus, there will be a large increase in demand for meat (Table 2).

Table 2. Meat production, consumption and trade, 1993 and 2020: million metric tonnes (Rosegrant et al, 1997).

	Consumption		Production		Net exports/imports	
	1993	2020	1993	2020	1993	2020
China	39	89	39	89	0.9	-0.4
India	4	8	4	8	0.1	-0.4
SE Asia	7	18	7	16	0.1	-1.8
Latin America	21	38	22	38	0.6	0.6
USA	31	37	31	41	-0.1	4.7
Developing world	89	193	88	182	-0.6	-11.5
Developed world	99	113	100	124	0.6	11.5
World	188	306	188	306	0.0	0.0

THE CONSUMER

A first essential in meeting the needs of the consumer is to define the product and its quality. In the case of meat, this can be considered as *carcass quality* and *meat quality.* Carcass quality is mainly related to the relative proportions of lean and fat in the body and, in many situations, has been a basis for bonus payments to the farmer. Efficiency of lean meat production has been the target of animal breeding and nutrition in recent years. Meat quality refers to the organoleptic properties.

The consuming public is well educated with access to information about their own health and attitudes have changed considerably regarding diet and exercise. The public perceptions of diet have been fuelled by national recommendations, largely based on World Heath Organisation (1982) recommendations. Generally, these have suggested a controlled energy intake with a maximum of 30% coming from fat and only 10% of the energy coming from saturated fat. Fat should be limited 77 – 87g/day and the target polyunsaturated/saturated fatty acid ratio should be 0.36. Cholesterol should be limited to 300mg/day.

Do such targets militate against the other expectations and demands of the consumer? Paterson (2000) quoted a survey reported in *Food Processing* (Food Processing 2000). Some of the relevant points were:

- 96% of consumers said that taste outweighs all other factors when it comes to food purchase decision. There must be 'guaranteed' taste and tenderness.
- Three in four people surveyed have tried to trim fat from their diets. Their strategy is to keep flavour in and fat out.
- Both women (67%) and men (54%) considered themselves to be overweight.
- Thirty-two percent of the women and 20% of the men said that they were currently on diets.
- The most popular weight loss strategy was portion size control.
- There is a growing desire for the family to eat together and not spend time preparing the meal.
- Consumers are motivated by clearly communicated benefits.
- In the absence of clear benefits, price will drive sales.

The question arises as to whether the dietary needs of human health militate against the acceptability and enjoyment of meat and meat products. The answer will affect the targets of

breeding, management and nutrition in the 21st century. For pigmeat, a possible compromise has been suggested as targets (Table 3). These targets reflect the UK situation but there is an international dimension to consumer preferences. For example, the Japanese like higher marbling fat (3% or more) and darker meat (Paterson, 2000). Many other national preferences exist.

the supermarket is, and will continue to be very important. In addition to influencing the nature and quality of the product they will have a marked influence on price, which may well be to the detriment of the individual producer. Supermarkets may get larger, become more global and there may be fewer of them, which would give them a bigger influence and more control over the producer. Each

Table 3. Targets for carcass and meat quality in 80kg carcasses. (after Wood 2001)

Carcass composition[1]	58-60% lean	
	12-14 mm P2 fat thickness	
	31% lean in leg and loin back	
Muscle quality[2]	pH_1	6.2-6.8
(*longissimus)*	pH_{24h}	5.4-5.7
	Drip loss	2-5%
	Lightness	53-57 L*
	Extractable lipid	1.0-2.0%
	(marbling fat)	
	Toughness	3-5kg
	Vitamin E	3-5mg/kg
Eating quality[3]	Tenderness	>4
(loin steaks)	Juiciness	>4
	Pork flavour	>3.5
Fat quality[4]	18:2	12-15%
(longissimus)	18:3	2-3%
	P:S	0.4

[1] Based on research at Bristol. P2 level higher than current UK average.

[2] Drip loss measured at 24-48h post mortem, drip collected over 48h. Toughness measured after 10d ageing at 1°C.

[3] Based on research at Bristol. Loin steaks griddled to 75°C internal temperature and assessed on 1-8 scales using 10-person trained taste panel.

[4] Based on research at Bristol. Percentages of total fatty acids.

The producer who must identify product targets clearly must take consumer requirements seriously. However, the question must be asked 'do consumers set the standards or is this done by an intermediary such as the supermarket?' The role of

part of the food chain must keep in touch with the rest. The nature of the supermarket as a retailer will change with the expansion of home shopping and the internet. The remote ordering of food will demand greater uniformity of product in order to

meet the consumer's expectations and maintain his confidence in retail developments.

While consumer demands will involve human health and eating quality, such as colour, taste, tenderness, juiciness etc, there will be large concerns over the safety of all food products. The absence of residues, such as antibiotics, heavy metals and pesticides is important and affects the operation of the producer, feed compounder and crop producer. Food must be free from microbial contamination, for example Salmonella but care also needs to be taken in domestic storage and preparation. Food scares such as BSE have shown how the consuming public reacts to apparent health threats. As a result, interest has centred on 'natural' methods of production based on materials having a 'non-artificial image'. It is important to recognise that consumer reaction is based on his perception of an acceptable product not necessarily on scientific fact. His reaction may result in changing buying habits and may also influence legislators.

Such concerns have helped increase the interest in 'organic' foods. Regulations exist within the EU, controlling the labelling of pigmeat as organic. EEC-Regulation No 209/91, supported by EEC-Regulation No1804/1999. defines the requirements, which are wide ranging. Generally the regulations attempt to set a framework for natural production in an animal friendly environment using organically produced foods. Details of weaning age, medication, stockman tasks (eg, tail docking and teeth clipping are banned) and housing conditions are specified. Organic pig production is often associated with outdoor housing, particularly of sows. Individual countries may have their own schemes for quality assurance, often associated with animal welfare. Such schemes may involve the food chain and include processed products. The consumer will weigh such considerations against cost and while this sector is increasing, it is still very small.

THE ANIMAL

In order to meet the challenge of feeding the world population it is necessary to provide sufficient product of the required quality. Providing the quantity may come from increasing the number of animals and/or increasing the output per animal.

Output per animal can firstly be considered as a reproductive rate. As far as the breeding sow is concerned an increase in productivity (eg piglets/sow/year, litter number) must be associated with the ability of the sow to nurture the greater number of piglets and/or there must be the development of sophisticated artificial rearing systems. Reproductive performance is generally regarded as having a low heritability and consequently techniques other than simple selection have to be considered eg, considering its component parts. Ovulation rate may not be limiting and, in the author's experience, is generally not the major factor. Uterine capacity and embryo survival are more important. It has been suggested that there should be consideration of those genes that affect conceptus development, uterine capacity and luteolysis together with the ER (oestrogen receptor) gene (Rothschild, et al, 1996). The use of the Meishan breed to increase litter size by 3 – 5 piglets compared with conventional breeds shows the need to consider all avenues of possibility.

As far as the growing /finishing pig is concerned, management decisions, such as weight at slaughter will be important but increase in yield will need to be consistent with product quality. Output and performance will be influenced greatly by genetics, management and nutrition. In this context it is important that nutritional knowledge keeps pace with genetic progress. In the past, nutritional research workers too often worked with inferior genotypes and established nutrient requirements inappropriate to the contemporary animals. Future research finances should be focussed on not 're-inventing the wheel' but directed to work with advanced genotypes to provide the nutritional standards for pigs of the day.

In getting to this stage, the geneticist must define his objectives well to avoid mistakes of the past. For example, the target of breeding for efficiency of lean meat production did not take into account the appetite factor, which had important consequences, particularly in meeting the lactational needs of the sow. Furthermore the geneticist must consider the breadth of his breeding objectives. New genetic technologies are, and will continue to become available to the scientist.

However, their use may be curtailed by legislation fuelled by public opinion. An example is the genetic modification of organisms (GM). This has many uses with medical production being an important one. However, there has been resistance to the use of GM animals and plants. Even the feeding of GM crops to food producing animals has caused concern.

Welfare. Our interest in welfare starts with the animal and there are minimum welfare standards in existence in many countries. In the United Kingdom the UK Welfare of Animals Regulations implement the EC Directive 91/630, which lays down minimum standards. These amongst other things give space allowances for pigs. For weaner pigs, the unobstructed floor area for each pig in a group must be:

- *0.15m^2 per pig, where the average weight is 10kg or less.*
- 0.20m^2 per pig, where the average weight is 10 – 20kg.
- 0.30m^2 per pig, where the average weight is 20 – 30kg.

Many consumers want to buy meat which they are assured has been produced under systems with high welfare standards. In the United Kingdom, the Royal Society for the Prevention of Cruelty to Animals (RSPCA) has developed a scheme to give approval to the methods of rearing, handling, transport and slaughter of pigs (RSPCA Welfare Standards for Pigs). The United Kingdom's Pig Welfare Code drawn up by the Farm Animal Welfare Council (DEFRA, 2003) is its basis and it carries the 'Freedom Food' label. The basis of the Pig Welfare Code is the five freedoms:

- Freedom from hunger and thirst.
- Freedom from discomfort.
- Freedom from pain, injury or disease.
- Freedom to express normal behaviour.
- Freedom from stress.

A number of countries are well advanced in their adoption of pig welfare schemes. However, the 'level playing field' argument comes into the reckoning. Farmers in welfare progressive countries have a legitimate grievance when their own country allows pigmeat importations from countries without such regulations, in that the high welfare systems are likely to be more costly. Conventions that have been adopted by the World Trade Organisation (WTO) and the General Agreement on Tariffs and Trade (GATT) have been an obstacle. Clearly there will need to be global agreements, which take a much broader view of international trade to include considerations that have been regarded as non-trade issues.

Health and disease. Disease control is important for the wellbeing of the animal and for its economic production. In the author's opinion, research into animal health has been one of the most neglected and under-funded areas of animal science. This has now become a much more urgent issue after experiences in recent years with zoonosis. The most important foodborne zoonotic diseases in Europe are Salmonella, Campylobacter and Yersina. MRSA has caused widespread concern in the human population. The relationship between animal disease and human infection has so far been more of a worry in the poultry industry. However, it does sound a clear warning to all the animal industries. An even greater worry would be that if mutations that have been spread from animal to human were then capable of spreading from human to human.

THE ENVIRONMENT

The population at large is greatly concerned about the environment, or more particularly, about pollution and the damaging effects on the planet. For example, the effects of Man's activities on global warming. Furthermore, people want to live in pleasant, unpolluted surroundings.

Europe has a population of about 700 million with an intensity which varies from sparse to heavily populated. Intensive agriculture tends to be situated near centres of population as well as in areas of good crop production. The climate varies from largely cold temperatures to sub-tropical. Each country has sought its own solution to the problems of environmental pollution. The options include:

- no regulations
- guidelines or codes of practice
- legislation to control emissions and/or animal production
- the banning of animal production

Nitrogen is of particular importance. In the United Kingdom, as far as the macro-environment is concerned it is an offence to pollute a watercourse under the Water Act (1989) However, the farming practices to avoid this are controlled by Codes of Good Agricultural Practice which suggest in relation to effluent application to land:

- matching land to N in waste (max 250 kg N from wastes/ha/year)
- application in correct conditions
- not more than 50m^3/ha of slurry or 50 tonnes manure/ha at a time: 3 weeks between each application
- adequate storage facilities

In nitrate sensitive areas, farmers enter into a five year agreement (for which they receive payment). The scheme involves the conversion of arable land to permanent grass, which should be either:

- unfertilised, ungrazed,
- unfertilised,
- receive a maximum of 150 kg/ha or
- unfertilised with planning

Air quality is of particular importance to animal performance, human health and the environment at large. The role of ammonia is a good illustration of this. Ammonia production is closely related to total nitrogen output; consequently legislation, which controls other components of animal excreta, will be beneficial. Gases are the breakdown products of organic components and others include carbon dioxide, carbon monoxide and hydrogen sulphide. They are components of pollution and odour and, at high levels can be a problem to animals and people.

While there is a reliance on codes of good practice in farming to control pollution, the microclimate (the animal house) has legislation to protect the worker. The United Kingdom has legislation controlling the amount of many substances to which the worker may be subjected (Health and Safety Executive, 1989). Maximum ammonia levels are given in Table 4 and any reduction will benefit both the worker and animal.

Table 4. Times for which workers in the United Kingdom may be exposed to various ammonia levels

Ammonia ppm	Below 25	25-35	Above 35
Exposure/day	8 hours	10 min	0

To avoid serious problems of animal health and performance and to alleviate human problems it is important to achieve good building design, adequate ventilation, optimum stocking density and an appropriate diet.

The matching of diet to the needs of the animal will be particularly important in controlling pollution as will all aspects of management. However legislation aimed to control pollution may not be what the producer would choose nor in the interests of scale of operation to maximise/optimise production. Within Europe, 25 countries comprise the European Union (EU) and others are negotiating membership. In addition to being a “common market” the EU seeks to harmonise many aspects of everyday life. The EU intends by 2007 that all pig units with more than 750 sows or 2000 fattening pigs (over 30 kg) will have to apply for an IPPC (Integrated Pollution Prevention and Control) permit. A permit will be granted if the Environment Agency is satisfied that the IPPC requirements regarding pollution are met.

Legislation. The challenges that the producer faces from the legislator are largely unpredictable. Some of the most serious legislation is that faced by member states of the European Union. These are well known with the banning of animal growth promoters being at the forefront. In this case, the legislation was brought in for good reason and farmers will look for alternative techniques to meet

any problems that they face. The absence of antibiotics for pigs will be felt most in the immediate post-weaning period. The response will entail taking a fresh look at the basics of nutrition at this stage and developing diets to meet the physiological and metabolic needs of the pig.

Animal welfare is an important issue to which all animal producers must pay particular attention. Due to the varied management standards of farmers, legislation is often based on the perceived welfare needs of the animal. For example in the UK, the government banned sow stalls in 1999 and weaning of piglets is not allowed before 28 days. Such unilateral decisions raise questions about a 'level playing field' for producers in different countries selling into the same market.

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UVOD

Usmjerenje proizvodnje životinja u 21. stoljeću ovisi o mnogo čimbenika. Neki se mogu ustanoviti predviđanjima na temelju prošlih kretanja dok drugi mogu biti posljedica još ne prepoznatih čimbenika. Opasnost predviđanja na temelju sadašnjeg rada je u tome da promjene vjerojatno neće biti linearne, a uzorak na kojemu temeljiti predviđanja je nepoznat.

Ranije su se ciljevi proizvodnje temeljili na potrebi optimiranja ili maksimiranja proizvodnje, na primjer, omjera konverzije hrane, reprodukcijske djelotvornosti. Kod životinja za proizvodnju mesa količina mršavog trupla smatra se važnom pa su programi uzgoja postavili za cilj djelotvornost proizvodnje mršavog mesa. Hranidba potrebna za održavanje ovakvih genotipova obično je ustanovljena nešto kasnije.

U zadnje vrijeme prepoznati su drugi važni ciljevi a prof. Mordenti je uveo princip AGE u proizvodnju životinja. Prema tom principu treba uzeti u obzir životinju, potrošača i okoliš. Međutim, pri tome ne bismo smjeli izgubiti iz vida potrebu zadržavanja proizvođača dajući mu financijski povrat na temelju postignutih ciljeva proizvodnje.

Proizvodnja životinja morat će se temeljiti na područjima gdje su dostupni hrana, voda, radna snaga i tehnologija, te po mogućnosti blizina potrošača. Takva stajališta mogu se kositi s konkurentnim zanimanjem za ruralnu zemlju. U Britaniji postoji sve veće zanimanje za ulogu sela u rekreacijskom bavljenju. Osim toga, snabdijevanje energijom na razne načine kao što su farme-energane na vjetar do usjeva za proizvodnju etanola moglo bi smanjiti proizvodnu zemlju koja je inače raspoloživa za proizvodnju hrane.