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Perspective

Effects of retailer pressure on the efficiency of agricultural industries

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Abstract. Considerable progress has been made in reducing starvation during the past century. This was achieved through increased use of arable land and adoption of new technologies. Future increases in food production will depend to a greater extent than in the past on the adoption of new technologies and must be even more rapidly achieved than in the past to meet the increase in demand for food. Intensive industries such as the poultry industry are under pressure from those engaged with a naturalistic fallacy. Technologies such as antibiotics for chickens or hormonal growth promotants (HGPs) for beef cattle that are safe for people, reduce environmental impacts of production, increase profits for producers, and improve animal well-being will be needed to achieve these increases in food production. The precedent set in the EU in banning HGPs can be understood as a response to the illegal abuse of diethylstilboestrol in the EU and as a non-tariff trade barrier to reduce the importation of beef from more efficient producers. The banning of antibiotics in the EU reflects the unwise application of a 'precautionary principle' through which risks were not soundly assessed. However, the unilateral ban established by Coles Supermarkets Pty Ltd on HGPs in Australia represents a more dangerous development, in which marketing ploys have been accorded a higher value than the care of animals, the environment, or the profit made by producers. Decisions such as these have reduced the viability of animal production in the UK and pose a threat to sustainable agricultural production in Australia.

Additional keywords: anabolic hormones, naturalistic fallacy, sustainable agriculture.

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Historical achievements in agriculture

Perhaps the most remarkable technological achievement of the 20th Century was the adoption of new technologies in agriculture, which resulted in fewer people starving in 2000 than in 1900. Associated with this change and with advances in medical science, human longevity has increased markedly in many countries (Fogel 2004). Despite this achievement, 1 billion people are still starving and 1 billion people still suffer from malnutrition (Anon. 2002).

Much of the success in reducing starvation was achieved through the 'Green Revolution', which was based on genetic selection of crops and the use of nitrogenous fertilisers, both of which resulted in higher crop yields (Borlaug 2000). In animal agriculture, the production of poultry and pigs has changed radically over the past century through the adoption of intensive housing, improved feeding strategies, and genetic selection. In the USA, poultry and egg production increased by a compound 3.55% from 1948 to 1994 (Ahearn *et al.* 1998), resulting in an increase in efficiency of ~500%. Similar, though less dramatic, changes were achieved with dairy and beef production. Animal products are important in human nutrition, as they are nutrient-dense and provide approximately one-sixth of human energy intake and one-third of protein intake (CAST 1999). The density and availability of proteins, the biological value of these proteins, and the bioavailabilities of macro-minerals and micronutrients (calcium, phosphorus, iron, zinc, magnesium, manganese, the B vitamins, niacin) in animal products are superior to those in vegetable sources (CAST 1999).

Despite concerns that animal welfare has been compromised as a result of intensification, the combination of application of new technologies and pressure to improve production associated with responses to lower economic margins for goods sold has resulted in marked improvements in animal health and well-being. This improvement is evident in the elimination of many animal diseases from substantial populations of animals, and development of anti-parasite treatments, better therapeutics, and vaccines. Better nutrition has greatly reduced animal morbidity and mortality. Housing conditions are constantly being improved to reduce morbidity and increase weight gain. Mistreatment of animals is at odds with efficient production and unacceptable to most farmers. However, there is a need to improve the housing and husbandry of animals as our understanding of housing and animal well-being grows.

Challenges for future food supply

Despite the achievements of the previous century, challenges remain in terms of food production; perhaps the most facing the planet is the need to feed 9–9.6 billion people by 2050 (Anon. 2002; Beddington 2011). Increasing demands for animal protein in emerging nations and increasing affluence in Asia suggest that, by 2050, we will require 100% more food than is currently produced. A more sanguine assessment by the Department of Environment, Food and Rural Affairs in the UK (DEFRA 2010) suggests that a 70% increase in food production is required, based on gains in post-harvest efficiency and using some different assumptions from those of the Food Agriculture Organisation of the United Nations (FAO) (DEFRA 2010; Beddington 2011). Several workers have noted the potential for geopolitical instability resulting from food shortages (Bienen and Gersovitz 1986). Notwithstanding differences in estimates of the amount of food that will be required in the future, we can be confident that increases in production will not be achieved by increasing the area of land set aside for food production. The Beddington (2011) report noted that more land would be lost to urban encroachment, salinity, desertification, and sea level rise in the future. The highly fertile San Joaquin Valley of California, for example, has lost 21% of available arable land to housing since peak land availability in 1986 (Anon. 2011*a*). There are also challenges with regard to water, energy supply, and phosphorus and potassium supplies for food production. The increased production of food will have to be driven by increased adoption of new technology.

The challenge under these conditions will be to implement sustainable integration of practices for providing food, fibre, and fuel from agriculture. Perhaps the most critical challenge is to define the term ‘sustainable’. A simple definition is ‘the capacity of the planet to meet current production needs for humans without impairing, and preferably enhancing, the capacity to meet future needs, while maintaining the biodiversity of populations of organisms on the planet’. It can be argued that maintaining the biodiversity of organisms on the planet is superfluous to the meeting needs without impairing and preferably enhancing the capacity to meet future needs but it could also be argued that we do not fully understand the potential of our ecosystem to benefit humanity. The maintenance of biodiversity, therefore, reduces the risk of loss of beneficial organisms.

Beddington (2011) considers that ‘More food must be produced sustainably through the spread and implementation of existing knowledge, technology and best practice, and by investment in new science and innovation and the social infrastructure that enables food producers to benefit from all of these’. In this context, it is worth examining the effects of societal, governmental, and retailer pressure on two technologies: the use of antibiotics for chickens, and the use of hormonal growth promotants (HGPs) for cattle. The effect of the European Union (EU) ban on certain antimicrobials is a matter of controversy; in Australia, the unilateral ban on HGPs by an Australian supermarket resulted in a strong response from Australian scientists who criticised the ban.

Social activism, the naturalistic fallacy, and food production

Slovic (2000) published a landmark series of studies that explored societal responses to risks associated with new technologies. Perceptions of risk vary markedly among individuals and are influenced by the level of knowledge of the risk and fear of the risk. It can be hypothesised that agriculture will face an increased risk of activism, because fewer people have a connection with the land and many have a poor knowledge of the technologies involved. For example, Slovic (2000) noted that the fear of nitrogenous fertilizer reflected this being a risk that is not observable or unknown to those concerned about it. Notable activist groups include the Luddite movement in the UK in the early 1800s, which fought against the adoption of new methods of textile production and industrialisation in general and reflected in part, vested interest, but also fear of change. Other examples include the organic movement that originated in Europe. Many of the adherents of such movements may be engaged in a ‘naturalistic fallacy’, where they equate natural conditions with superior outcomes. The naturalistic fallacy was described and addressed by the philosophers Hume and Moore (Greene 2003; Tanner 2006). The position of those opposed to modern animal production systems is exemplified by a response made by Mr Brian Sherman, a former financier and animal activist, in the Australian Newspaper (Sherman 2011) in which he argued against positions presented by 40 of Australia’s leading animal and veterinary scientists (Anon. 2011*b*) regarding the unilateral ban by Coles Supermarkets Pty Ltd on HGPs in Australia. Regarding the management of pigs, Mr Sherman argued that we ‘know and feel instinctively’ that natural is better. It is not difficult to challenge the naturalistic fallacy. If we relied on such ‘natural systems’, humans would live to an average of ~35 years, have a high risk of death in childbirth, and suffer high rates of infant mortality. Natural or organic systems cannot provide sufficient food to feed the current human population (Trewavas 2001; Beddington 2011). Moreover, the extended period of co-evolution between humans and domestic animals over the past 10 000–14 000 years redefines concepts of ‘natural’ with regard to domestic animals. This is particularly pertinent to poultry production. The naturalistic fallacy has also been invoked by spokespersons for Coles. Mr Durkan of Coles said that consumers are seeking ‘natural food grown under ethical production’. No data have been provided by Coles to support their contention that consumers desire this (Herald and Weekly Times 2011). Without quantitative data and clear evidence of the structure of survey questions, it is difficult to assess the strength of the assertions from Coles.

Antibiotics and poultry production in the EU

In 1999, the EU banned several antimicrobial agents used in agriculture, particularly in poultry production. This ban was extended in 2006. These decisions were made despite the advice of the EU’s own Scientific Committee on Animal Nutrition (SCAN 1996, 1998*a*, 1998*b*) and a review by the EU courts that concluded that there were logic flaws in the decision to implement the ban (Forrester and Hanekamp 2006). The ban reflected the adoption of the ‘precautionary principle’ invoked by EU regulatory authorities (Forrester and Hanekamp 2006) on the basis that there was a risk to human health because of the use of antibiotics in poultry production (Castanon 2007; Phillips 2007). In the UK, retailer pressure was a factor in promoting these bans (Anon. 1999).

Fleming (1945) raised concerns about the possibility of antibiotic resistance as early as the 1940s. Subsequently, the problems of transmissible plasmids, genetic material that can be passed from bacteria to bacteria and transmit antibiotic resistance, and the potential for the dissemination of antibiotic resistance were examined in Swann (1969). Outcomes from that report led to the development of prudent-use criteria for antibiotics and the removal of some antibiotics from veterinary use. From the early 1970s, veterinary curricula included detailed information on the potential for the inappropriate use of antibiotics to increase the prevalence of resistant bacterial populations in animals and in man. The risk to man from antibiotic use in animals has been reviewed by several authoritative bodies, including Heidelberg Appeal Nederland (1999), NRC (1999), SCAN (1996, 1998*a*, 1998*b*), and OIE (1999). All of these reviews found little risk of in-feed antimicrobial treatment increasing treatment failure in humans. After >60 years of use of antibiotics in agriculture, there are few, if any, documented cases of in-feed antibiotic treatment of animals causing treatment failure in humans.

However, there continues to be an active media campaign implying or stating that the risk of human treatment failure is high because of antibiotic treatment of animals. In the 10–15 years since many of the reports cited above were released, much money has been spent searching for links between animal treatment and infection or treatment failure in humans. The lack of findings of treatment failure or infection does not reflect a lack of surveillance, because surveillance using sophisticated gene probe methods has been extensive in many countries. Furthermore, evidence based on risk-assessment approaches indicates that while there is potential for such a hazard, the risk is very low (Cox and Popken 2004*a*). This is not surprising, as there are steps to intervene between the use of antibiotics in animals and treatment failure in man. Casewell *et al*. (2003) suggest that indicators of human health relevant to risks associated with antimicrobial use in animals may have deteriorated in association with, or even as a result of, the ban.

Recent risk assessments estimate that the upper limit (maximum) for preventable deaths resulting from an immediate ban of the use of virginiamycin in all species in the USA (population ~250 million) would be <1 person in the next 15 years (Cox and Popken 2004*b*). To put this in context, the death rate from bee stings is 1 per 6 million people per year and the death rate from dog bites is 1 per 18 million people per year. The perspective of epidemiologists (Casewell *et al*. 2003; Phillips *et al*. 2003; Doores *et al*. 2003) contrasts greatly with that of microbiologists, as is evident in the consistent support of microbiologists for bans based on precautionary principles (Turnidge 2004). The impact of these bans on animal health and productivity is unclear, as the experimental design of many of the studies examining the influence of antibiotic bans on pig performance in Denmark is poor. However, several studies reported declines in poultry health and productivity following the ban, whereas others noted a decrease in tonnes of antibiotics fed following the ban.

There are three key aspects of these bans: (i) the risk of banning in-feed antibiotics on human health is bi-directional, in other words, removal of preventive medicines can increase the use of therapeutic antibiotics, which also impose risks to man; (ii) in industries such as the poultry industry, small changes in the efficiency of production are critical for profitability; and (iii) a mix of fear and activism can result in poor policy. Rivera-Ferre and Ortega-Cerda (2011) highlighted the need for more sophisticated approaches to making policy decisions in agriculture based on an understanding of the role of ignorance in decision-making. The article argues for a more integrated approach to making agricultural decisions that engages with uncertainty, ambiguity, and ignorance in addition to risk assessment.

Hormonal growth promotants in the beef industry

A recent example of retailer pressure is the unilateral ban of Coles Supermarkets on HGPs. This decision replicates bans on such products in the EU. Hormonal growth promotants were first used in the USA the late 1940s and in Australia in the late 1970s. Early growth hormone research was a response to the food deprivation associated with the World War II, and the initial investigations were designed to mimic the endogenous steroid and peptide growth hormones produced by livestock. Diethylstilboestrol (DES) was used in some countries and in the early trials; DES has the potential to persist in meat, where it remains hormonally active. Furthermore, concerns were raised with regard to the carcinogenic potential of DES. These results led to concern about the safety of HGPs. Consequently, subsequent products have been extremely rigorously assessed for potential risks to consumers.

Several HGPs are registered for use in Australia and in ~40 other countries. These include naturally occurring steroids (oestradiol 17β, oestradiol benzoate, progesterone, and testosterone), a synthetic steroid (trenbolone acetate), and a synthetic non-steroidal oestrogen originally derived from a naturally occurring fungus (zeranol).

In Australia, HGPs are evaluated for safety and efficacy in animals by the Australian Pesticides and Veterinary Medicines Authority and the Therapeutic Goods Administration before registration. In the USA, HGPs are evaluated by the Food and Drug Administration (FDA 2011) before registration. Further opinions and reviews are provided by the most widely recognised authorities on the safety of therapeutics in food, the Codex Alimentarius Commission, the Codex Committee on Residues of Veterinary Drugs in Foods, and the Joint Expert Committee on Food Additives, and are reviewed by Kastner and Pawsey (2002). All of these organisations and other national registration authorities have concluded that the HGP are safe for human use based on the biology of the products and their residues. A further independent and authoritative independent review, the Lamming Report of 1982, commissioned by the EU, concluded that the HGP are safe for humans. This report was suppressed by EU authorities, but was published by the committee in 1987 (Lamming *et al*. 1987). The conclusions of the Lamming Committee were confirmed by a joint World Health Organization/FAO committee (Anon. 1988). Despite these consistent findings from regulatory authorities, the EU banned the use of HGPs in 1985 and banned imported beef from countries including the USA and Canada in 1989. A full review of the safety of these products for humans is available from APVMA (2011).

The genesis of the EU's political antagonism to HGPs can be understood in the context of several major influences. There had been abuse of DES in some member states of the EU, especially Italy, in the early 1980s (Passantino 2012). This abuse had justifiably raised consumer concerns about food safety with regard to hormone treatments. Furthermore, policies in the EU were designed to reduce overproduction of subsidised food, including beef. The Common Agricultural Policy of the EU involved minimum pricing for products, trade barriers, tariffs, and market controls that were directed towards providing protection for internal markets on the basis that many of the member states wished to protect their farmers and maintain viable rural populations. Consequently, means of reducing access to products from countries that were producing meat more efficiently were devised, i.e. non-tariff trade barriers. These factors lead to the invocation of the 'precautionary principle', which resulted in a decision by the EU to ban HGPs despite the overwhelming conclusion by those who examined the human safety aspects of the HGPs that the products were safe. A consequence of the ban on HGPs was that in an action undertaken under the aegis of the World Trade Organisation, the USA and Canada gained reparations from the EU to the value of US$93 million per annum on the basis that the ban was not based on science or a proper risk assessment (APVMA 2011).

Safety and efficacy of HGPs in cattle

The use of HGPs has been the subject of substantive, quantitative literature reviews (Preston 1999; Wagner *et al*. 2007; Hunter 2010). Responses of cattle to HGPs are positive and consistent when they are fed adequate diets. The growth rate of steers and heifers is increased by 10–30% and feed conversion efficiency by 5–15%, and the fat content of carcasses is reduced by 5–8% (Preston 1999; Hunter 2010). A review of studies conducted in the north of Australia by Hunter (2010) shows that cattle treated with HGPs before the wet season have the potential to maintain weight gains achieved in the wet period into the dry season. This is important for production, the efficiency of production, and for meeting the criteria of high-value markets and animal well-being standards. Table 1 outlines the positive and negative aspects of using HGPs on cattle performance, the environment, profitability of production, and meat quality. The HGPs have substantial positive effects on the environment, as up to 40% of Australian cattle are treated with HGPs. The negative impacts of HGPs on cattle health outlined in Table 1 arise infrequently and were not of sufficient concern to prevent registration of the products. The positive value of additional body tissue reserves, especially in adverse nutritional environments, can be substantial. Claims that HGPs affect the capacity of cattle to thermo-regulate are based on a single flawed (temporally pseudo-replicated) study (Gaughan *et al*. 2005). These products have, on balance, positive effects on cattle health, especially in northern Australia.

The annual increase in the profit of agricultural producers of AU$210 million estimated by the New South Wales Department of Agriculture should be viewed in the context that many beef producers do not make a profit (Mackinnon 2009). In the poultry industry, even modest improvements in returns have a large effect on profitability. Products that enable producers to meet the specifications of high-value markets, reduce environmental impacts, and improve animal well-being have a valuable role in cattle production. The effect of HGPs on the eating qualities of meat has been used by Coles to support their position in banning HGPs. A meta-analysis (Watson 2008) on the effects of HGPs on beef palatability provided evidence of negative effects of HGPs on tenderness and palatability. Very few individual studies reviewed by Watson (2008) showed negative effects of HGPs on meat tenderness or palatability, but the overall effects were significant and consistent in the meta-analysis. However, there is a difference between the significance and the importance of an effect, and the effects of HGPs on meat quality are modest. Hunter (2010) noted that tenderstretch methods and ageing prevent these negative effects. Furthermore, the reduction in meat lipid content associated with HGP treatment can be viewed as a positive effect, in that leaner beef is produced, albeit with reduced flavour. These effects on meat quality, both positive and negative, are incorporated into the Meat Standards Australia grading system, which accounts for all variables that have an influence on meat quality. Consequently, the claims of Coles with regard to the effects of HGPs on meat quality lack a sustainable, rational basis and they have been refuted by Meat & Livestock Australia (Gorman 2011) and the CSIRO (Bell 2011), organisations whose work was cited by Coles in support of their ban.

It is difficult to assess the impact of retailer activism on food buying habits. Recent surveys in Australia suggest that beef sales by retail butchers have been maintained and that the beef sales of Woolworths Supermarkets have increased to a greater extent than those of Coles. Data supplied by Beef Central (2011) indicate that Coles 'Hormone-free beef' campaign had little impact on their sales of beef. The market share of independent retailers was maintained at 29.4% and that of Woolworths increased from

Table 1. Positive and negative effects of hormone growth promotants (HGPs) on cattle performance, the environment, profitability of production, and meat quality

Area of impact	Positive effect	Negative effect
Animal health	Weight gains retained into the dry period	Buller steers (steers that are excessively mounted by other cattle), behavioural changes, rare abscess formation at implant sites
Animal productivity	Production increased by 10–30%; 10–15% reduction in intake; overall efficiency of production increased by 30%	Nil
Sustainable management	Reduced use of land and water, reduced greenhouse gas production	Nil
Profit	Value in 2008, AU$210 million	Nil
Meat quality	Requirements of high-quality markets met by use in Northern Australia, reduced fat in meat (Hunter 2010)	Reduced meat quality, overcome by ageing the carcass or tenderstretch methods (Hunter 2010)

27.5% to 28.9% over the preceding 3 months, whereas a smaller increase from 20.8% to 21.6% was recorded by Coles. More recent findings published by Beef Central and based on independent survey data for the next quarter of 2011 suggest that Coles was losing market share in this sector (Condon 2011).

Societal risks of arbitrary bans on animal health and performance technologies

There is no agreed ethical basis by which marketing is conducted; rather, the ethics need to be determined by each organisation in marketing. However, it is disingenuous to claim that a ban on a product 'is just marketing.' A decision to reject legal, regulatory agent-evaluated, industry-accepted technologies implies that such technologies are considered flawed. This assertion resonates with the statements cited above that Coles are seeking to produce food on a 'more ethical basis'.

The effects of arbitrary bans on technologies can be serious. The ethics are complex and the application of any new technology is associated with some degree of uncertainty. It has been argued that is important for scientists to engage with policy makers to explore the complexity of applying new technologies from a rational and risk-based perspective using qualitative and quantitative assessment methods (Stirling 2010).

Perhaps that most substantial effect on human health has resulted from the ban initiated by EU activists on genetically modified (GM) 'golden rice'. This GM rice, which includes a gene to produce β-carotene, was developed to address the needs of much of the population of the Indian subcontinent for β-carotene to prevent blindness. It has been argued that a 9% reduction in disability, blindness, and death associated with vitamin A deficiency in India per annum (equivalent to ~1.4 million healthy life years) could be achieved more cost-effectively using GM rice than by other means (Stein *et al*. 2006). Despite previous positions with regard to the adoption of technology driven by consumer activism and agro-political positions, the EU responded to the impending challenges of food security and overturned their previous position on GM crops. Beddington (2011) argues strongly for the use of GM crops to allow sufficient and efficient production to be achieved. Despite that argument, activist pressure and a hostile regulatory environment has lead Monsanto to withdraw applications for GM crops in Europe (Cressey 2013).

Coles' decision to ban HGPs could have had flow-on effects through other retailers and could result in a loss of AU$210 million for beef producers. An arbitrary ban on a technology can have other profound effects. Such actions create uncertainty among those wishing to improve animal well-being and production through the use of new technologies. Any new technology will have some adverse effects, whether these are minor adverse reactions in animals, such as in the case of HGPs, or more substantial effects on production systems, such as in the case of animal housing.

If retailers were to simply use any difference in the market to implement a ban, this would raise doubts about investments made in new technology by universities, other research organisations, or commercial entities with vested interests, such as feed and pharmaceutical companies. Furthermore, such bans make production less viable within a country and make producers less profitable and efficient, thereby increasing the environmental footprint of production and increasing vulnerability to imports. The effects of policies in the UK, largely lead by Tesco and similar to those of Coles, on the UK farming community have been devastating. The UK was a net food exporter but now imports food, including beef and poultry meat (AgriStats 2011).

Conclusions

It is clear that we need to produce more food in the future. The increase in production will have to originate from the adoption of new technologies. The rejection of technologies such as antibiotics for chickens or HGPs for beef cattle, which increase producer profit, improve animal well-being, provide safe, highly nutritious food at reasonable cost, and reduce the environmental impact of production, should be regarded as unethical. In addition, the potential of such bans to increase the cost of animal production and hamper the adoption of new technologies needed to feed the future population should be regarded as extremely worrying. The ban on HGPs by Coles stimulated an unprecedented response by senior and leading agricultural and veterinary scientists for these reasons.

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