Societal expectations of livestock farming in relation to environmental effects

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Summary

The potential environmental effects of livestock farming are mainly associated with intensification of production systems. The major impacts are caused by systems of poultry, pig and dairy cow production where housing can lead to air and water pollution associated with nitrogen and phosphorus from manures. Silage for ruminant feeding also poses a threat to water quality. European society regulates the potential for these types of pollution through a number of European Union directives and national legislation. In grazing systems, nitrogen pollution, associated with the use of nitrogen fertilizer and grass/clover swards, is also legislated against. Perhaps because of this regulation, surveys of the public have found that human food quality and animal welfare are far more important issues than effects on air and water quality when considering livestock systems.

High or low stocking rates of cattle, sheep and goats, grazing semi-natural or natural pastures can change the structure and composition of vegetation with potential impacts on biodiversity. Through Common Agricultural Policy instruments, maximum stocking rates can be set in order to reduce impacts on biodiversity in Europe. Ruminants contribute to emissions of greenhouse gases through the production of methane. Such stocking rate limits are the only mechanism for regulating ruminant numbers. Surveys of the public have suggested that they are willing to pay for the mitigation of these environmental effects but that they also value the cultural component of grazed livestock systems.

Introduction

As an ecologist with a research training in livestock production systems, my usual approach to the delivery of a review paper would be to review the evidence on the subject and then draw conclusions, usually in the form of testable hypotheses, which would add to the consensus view that existed among other scientists about the subject. Such an evidence-based approach is not appropriate for the title of the paper that I have been asked to give.

I have been asked to review the societal expectations of livestock farming in relation to environmental effects. It is possible to review the known environmental effects of livestock farming, and indeed I will summarise them. There are clear effects of the intensification of livestock systems, particularly in poultry, pig and dairy cow systems, which have occurred in the last century. These effects on air, soil and water quality are well documented. The impacts of changes in sheep, goat and cattle numbers on

biodiversity and air pollution have also been quantified. It is also possible to describe the responses that governments, presumably reflecting some view of society, have made.

It is less easy to review societal expectations. There is no clear unifying view about societal expectations on which to build and the evidence on the subject has little solidity. Indeed in a postmodernist's view, the traditional scientist's approach to a social science problem by providing evidence and drawing conclusions would be dismissed out of hand. It would be argued that it is not possible to describe and analyse, objectively and truthfully, and therefore with universal application, the social reality which surrounds us, let alone something as ephemeral as "societal expectations". Moreover, it would be argued that hidden moral, ideological or local cultural constraints make it impossible to form a view which would have universality (Butler, 2002). For example, I am a scientist with thirty years experience, from the UK, with a farming background, whose formative intellectual decade was the 1960s and whose main research interest is the study of ecosystems with large herbivores present. This is bound, it would be argued, to set a context for my conclusions about "societal expectations". In consequence, whilst I believe that it is possible to put in place some general concepts of the view of society about livestock systems, which might be accepted as being true for European society, it is not possible to be totally truthful about expressing a view on societal expectations which will not reflect my experience and attitudes. This difference between truth and truthfulness (Williams, 2002) is an important distinction to make. In discussing societal expectations, I will attempt to point out where my cultural influences may be occurring and take an intentionally sceptical view in seeking both truth and truthfulness.

The structure of my paper will therefore be to:

(1) describe briefly the environmental impacts of past and current, and possible future livestock systems,
(2) outline governmental approaches, which mainly involve regulation, to mitigate the environmental impacts of livestock systems, and
(3) explore the area of societal expectations.

Environmental impacts of livestock systems

Livestock farming in the twentieth century has resulted in significant impacts on ecosystem services. In relation to the provision of air quality, the quantities of methane and nitrogen produced by livestock may have or have had major impacts. On a world basis, approximately 80 – 100 m tonnes per year are currently being produced by farm livestock (Crutzen *et al*., 1986). The amount produced is a function of the numbers of ruminant livestock, their size, level of productivity, and type of diet with low-quality diets producing proportionately more. Approaches to reducing methane production through changes in diet, manipulating the rumen flora, and the administration of chemical and drugs, have been and are being advocated. Some of these approaches may work when ruminants are housed but are unlikely to have application to ruminant livestock that are extensively managed (Howden and Rewyenga, 1999). In the context of global warming gas emissions,

because ruminants are only one source of methane and methane from ruminants is not nearly so important a source of such gases as carbon dioxide, it has received a lower priority than might have been anticipated. A further reason is that the mostly likely way to reduce emissions is by reducing the numbers of ruminants, which have an important role in the production of meat, milk and fibre, and the provision of other ecosystem services.

In relation to nitrogen emissions and air quality, local effects can occur through ammonia production from manure from housed poultry, pigs and ruminant livestock, and from the release of ammonia from faeces and urine in intensively grazing systems where high levels of nitrogenous fertilizer are used. The impacts are on increasing the concentration of NO_x gases in the atmosphere, which contributes to the acidification and nitrification of soils and water, and hence on the productivity of ecosystems and also human health. As a result of increases in such gases in the atmosphere, changes in the composition of plant communities have occurred, for example in the Netherlands (Heil and Aerts, 1993), and a loss of fish species from waters through acidification has occurred in many countries of northern Europe (Ormorod and Gee, 1990). One of the issues here is that the time for recovery of these systems is likely to be as long as fifty years.

Water quality is mainly affected (a) by the movement of nutrients from manure sites, (b) through the application of manure to soils as a fertilizer and (c)the application of mineral fertilizers to crops subsequently fed to livestock. There are also issues relating to additives to feeds and silage effluent. The impacts can result in nutrient saturation in soils and eutrophication of water courses, leading to major changes in aquatic ecology. High concentrations of compounds in water can also lead to the water being considered unsafe for human consumption. Mitigation measures include the appropriate positioning of housing for livestock, the building of new manure systems, which minimise the risk if contamination, and the disposal of manure to land in ways that reduce the likelihood of nutrients reaching watercourses (Jarvis *et al*., 1996). Because there is a mixture of point source (housing) and diffuse pollution (disposal to land), approaches to manage the impacts are now being made at the level of the catchment.

The above descriptions have implied that in the last century livestock systems of poultry, pigs and dairy cows have intensified, mainly through increases in the size of enterprises and by virtue of controlled environment housing, leading to a general negative effect on ecosystem services. Livestock systems involving grazing have the potential to increase as well as decrease ecosystem services, through the impacts of grazing, trampling and excretal return (Illius and Hodgson, 1996). Grazed ecosystems are complex and it is the combination of climatic conditions, stocking density and livestock species which are the main determinants of their function. Although there a large number of services provide by grazed ecosystems, those relating to biodiversity are the most valued in Europe. There is a classical bell-shaped curve which relates measures of biodiversity to plant biomass (see Milne, 1996). You should note that I have not attempted a definition of biodiversity. Whilst research scientists would probably argue that what is required is the maintenance of sufficient diversity for the ecosystem to function satisfactorily, there is little agreement about definitions of functionality or how it can be achieved. Species number or keystone

species are poor surrogates for functionality but are where our understanding rests, or more properly where the understanding of policy makers and the general public rests.

In temperate grassland there has been an evolution to simple mono-specific grass or grass/clover pastures. Uncertainties of weather or soil in such systems can be buffered by the use of fertilizers or supplementary feed. Such systems have a low plant biodiversity and hence a low provision of biodiversity services. This has lead to the development of more extensive forms of management, i.e. often with reduced stocking densities, and combinations of livestock species, although the increase in biodiversity services achieved has often been small.

In Mediterranean regions high stocking densities of particularly sheep and goats have existed for several thousand years. Such ecosystems are often considered to be degraded and not providing a sufficient range of ecosystem services but there is a counterargument that they have reached a sustainable equilibrium (Perevolotsky and Seligman, 1998). Reductions in stocking density can lead to shrub encroachment and increased summer fire risk. In such circumstance an increase in stocking density would lead to an increase in biodiversity services.

Approaches to mitigating the impacts of livestock systems

A large number of approaches to the mitigation of the effects of livestock systems have been used in different countries in Europe. There tends to be a cascade of mitigation schemes down from a European Union level, to that of individual countries, and then through regions to livestock units with degrees of implementation being delegated to each level varying on the issue. Mitigation measures have centre round regulation-led, incentive-led or voluntary approaches or a combination of all of these approaches. The choice of the approach used relates to the objectives, the ease of identification and measurement of key variables, either at the source of the pollution or where it has its impact, cost-effectiveness, and political sensitivity (Hodge, 2001).

If the objectives relate to an issue that is perceived to be of high important, such as environmental impacts that may influence human health, for example, water quality, then a regulatory approach may be attractive. Often ecosystem services are perceived as being less important and a combination of regulatory, incentive and voluntary approaches is commonly used.

In general terms, impacts of livestock systems on air and water quality have in the past been based on a combination of regulation, usually at the point where there is an impact on ecosystem services, incentives, often at the source of the pollution, and voluntary approaches through education and the provision of information. For example, regulation has occurred through the monitoring of rivers or lakes for nitrate or phosphorus concentrations, or BOD values in relation to silage effluent pollution, and the imposition of fines or the zonation of areas for subsequent remedial action e.g. Nitrogen Vulnerable

Zones. However there have also been incentive-led approaches with grants for the erection of slurry pits or lagoons to avoid pollution. Equally there have been campaigns to educate farmers on the positioning of silage pits, and the most appropriate methods of application of slurry to minimise losses to the atmosphere or watercourses. These have been followed by Codes of Practice, some of which have been made mandatory. Many of these approaches have targeted individual management units but the Water Framework Directive of the European Commission is planned to be implemented at the catchment level, which will require community and collaborative approaches to the delivery of objectives.

Many of the mitigation measures put in place in relation to air and water quality have not been via the European Union's Common Agricultural Policy instruments apart from those that have been set for cattle by milk quotas or restrictions on the numbers of cattle which have an indirect effect on air and water quality through the number of livestock kept by farmers. The fact the pigs and poultry are not within the Common Agricultural Policy is a major reason for other approaches having been used.

This is not the case in relation to biodiversity where most of the mitigation measures, if not all, are in relation to elements of the implementation of the Common Agricultural Policy. There have been restrictions on numbers of grazing sheep, goats and cattle eligible for payment, as the main indirect route of controlling grazing impacts. Under EC regulation EEC 2078/92, financial incentives to deliver environmental benefits have been in place for over 10 years in the UK but the delivery in relation to biodiversity has not been high with the biodiversity of habitats only being maintained and not enhanced (Crabtree and Milne, 1998). Within the new Common Agricultural Policy cross-compliance in relation to good agricultural practice will have an influence on the delivery of biodiversity and the Pillar II proposals on environmental protection will also be able to be used. However different countries have chosen to implement the new policy in a number of different ways so that it is not easy to identify how the new policies will lead to the implementation of mitigating the effects of livestock farming on biodiversity.

It is easy to criticise the past efforts at mitigating the effects of livestock farming on biodiversity. As has been described above, there are no clear descriptors of biodiversity which will stand the test of time. Effects of the particular density of a livestock species can be positive or negative depending on climatic and soil conditions even for one habitat. Changes in biodiversity can be small and slow to occur. Even the simplest of measures of biodiversity can be difficult and expensive to make and then interpret.

In an ideal word one would measure fluxes rather than concentrations of key variables in assessing environmental impacts but the former is difficult to measure and consequently the latter is commonly used. Similarly it may be difficult to obtain measurements of key variables. For example, whilst the health of the biota of aquatic systems may be a key measurement variable in considering the pollution of rivers by livestock systems, concentrations of nutrients, which can lead to eutrophication, are often used as surrogates because of the ease of their measurement. The European Commission has been particularly active in setting levels for key variables, often based on the precautionary principle, and

sometimes with a limited amount of evidence on which to base their technocrat-led decision-making.

Cost-effectiveness is important for the obvious reason that policy-makers are under considerable pressure to deliver a benefit at minimum cost to the regulator and to those being regulated whilst achieving the objective. Equally the policy-maker has to take into account political sensitivities relating to perceptions of over-regulation on the one hand and ineffectiveness of the approach on the other, and the power of different lobbying groups. There is also a dynamic in that understanding of the functioning of ecosystems increases and new measurement methods are developed which impact on cost-effectiveness. There has been much discussion on the most appropriate approach to measurement to use in a particular circumstance and no clear resolution of that debate.

Monitoring the efficacy of different mitigation approaches is difficult and there is a need for the development of alternative approaches to aid policy-makers The cost-benefit of the different global within-country approaches that have been used is considered to have been low. What has become generally accepted is that local approaches, at the regional or farm level, are likely to the most successful even though the transaction costs of such schemes are high. It is becoming recognised that they are best designed in collaboration with the land manager and that some type of contract is entered into whereby biodiversity is delivered through a management plan which is paid for. Payment is more for the adherence to the management plan than for the delivery of biodiversity. Farmers are also recognising that livestock can have a value as biodiversity and landscape providers which may have a higher monetary value than the production of meat, milk and fibre.

Societal expectations

From the description above of the impacts of livestock on ecosystem services and the various approaches to delivering environmental goods, it would be thought that society valued these services highly. However surveys that have been conducted about what members of society value highly in relation to agriculture or the rural economy have found that society values the environment less highly than might be expected. In a review of surveys of what the public wants from agriculture and the countryside, it was found that food quality, animal welfare, cultural issues, and landscapes were valued as highly if not more so than environmental issues, depending on the manner in whch the survey was carried out (Hall *et al*., 2004). Whilst it may well be that extensive or organic farming can provide more environmental goods than highly intensive forms of livestock farming, there is little evidence that food quality is likely to be higher. Yet those who extol such forms of production are more likely to use food quality then environmental benefits as the reason for these forms of farming. One can only draw the conclusion that they have been discussing how to portray their production systems with market researchers. Similarly from other surveys the cultural and landscape value of pastoral systems were considered to be equally, if not more, important than the environmental goods that they deliver (Crabtree and Milne, 1998).

Another strand of evidence is that which derives from willingness-to-pay studies for environmental change. These assess through questionnaires or interviews how much samples of the population are prepared to pay to secure environmental benefits or prevent environmental losses. The results of these studies in relation to environmental changes that arise from grazing ruminant livestock in the U.K. suggest that the general public are prepared to pay more than the current levels of support through the Common Agricultural Policy (see Crabtree and Milne, 1998). Although these contingent valuation methods have considerable weaknesses, they do support the view that society does value the delivery of environmental benefits from livestock farming. However, these studies have found it difficult to tease out environmental from wider cultural landscape issues.

I suggested at the beginning of my paper that I believed that there were some general underlying universal concepts about the way that society views the environmental impacts of livestock farming. The first of these is that it is difficult for society to separate out the delivery of environmental services from other services of livestock farming, such as cheap food of a certain quality and safety, and cultural landscapes. The second is that the importance of this basket of services declines with the number of generations since the person lived on the land. The third is that at higher standards of living environmental issues become more important.

I would argue that the consequence of the combination of these concepts is that, on balance, in the next few decades, there may be no major change in societal views on the environmental impacts of livestock farming. The number of generations from active involve on the land is increasing whilst standards of living are increasing. Societal views on the balance between food quality, cultural landscapes and environmental concerns are continually changing. At present, food quality is a major focus whereas ten years ago it was less significance. I perceive an increase in interest in cultural landscapes as a means of capturing wealth for rural populations so that they can be maintained not only by livestock farming but through diversification and pluriactivity. Environmental concerns relate more to water quality through the human consumption of water than to biodiversity issues. It is only when society understands more about ecosystem services, and identifies that the current approaches are not delivering them sufficiently, that environmental concerns will rise in importance. These are views that have been filtered through my cultural perspective and may not the cultural perspective of others. It should also be recognised that social expectations can change rapidly due to specific events that cannot necessarily be predicted easily which may lead to perturbations which may be often but they also can lead to paradigm shifts in societal expectations.

Why, then, do European governments invest considerable effort in attempting to mitigate the impacts of livestock farming on the environment? One reason is because they are part of the basket of issues that I have described above. Environmental issues can be more easily identified for payment than some of the cultural or food quality issues, even though the likelihood of successful delivery may be relatively low. In that way they are attractive to policy makers in that a specific relatively non-controversial issue can be identified and a scheme of delivery put in place with a simple reward mechanism. Another reason is that

non-governmental lobbying organisations for the environment, at least in some parts of Europe, are strong and can influence the policy agenda of national governments and the European Commission.

One part of society is the small, and declining, number of livestock farmers. Their attitudes can influence not only the uptake and successful implementation of mitigation measures but also whether such measures are introduced. Studies have shown that in the last decade there has been an increase in farmer's awareness of environmental issues and a change in their perceptions in their role as custodians of the countryside (Bullock and McHenry (1997). With the decoupling of support from production in the reform of the Common Agricultural Policy of the European Union, it is likely that farmers in those sectors of livestock farming previously receiving support for production will receive a lower proportion of their income from the sale of products and a higher proportion of their income from the delivery of environmental goods. In such circumstances their attitudes will be such that they may actively welcome financial support for the delivery of environmental goods. The thinking behind Land Management Contracts between the state and farmers, or groups of farmers, currently being introduced into parts of Europe, is that delivery is more likely to be successful through a combination of incentives and regulation with the active involvement of farmers. Much of the same type of argument will be applied to the implementation of the Water Framework Directive over the next ten years although pig, poultry and dairy farmers currently suffer from a greater emphasis on regulatory mechanisms than incentives.

In conclusion, I have described briefly the environmental impacts of past, current and future livestock systems. I have identified the major strategies that governments on behalf of society have used to mitigate the effects of environmental impacts on livestock systems and I have attempted to explore societal expectations of livestock systems in relation to environmental impacts. I am confident that increases in understanding of the environmental impacts of livestock farming and methods of mitigating them will occur, and more effective approaches to designing systems of mitigation will be developed. However, it is more difficult to identify the direction that societal expectations will take although I have concluded that in the next decade they will remain at more or less the same level of importance as they are currently at.

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