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New directions for sustainable animal production systems and the role of animal welfare.

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Summary

Truly sustainable animal production systems are urgently needed. A system or procedure is sustainable if it is acceptable now and if its and if its expected future effects are acceptable, in particular in relation to resource availability, consequences of functioning and morality of action. What might make an animal usage system unsustainable? The system might involve so much depletion of resource that it will become unavailable. Alternatively, a product of the system might accumulate to a degree that prevents the functioning of the system. However, any effect which the general public find unacceptable makes a system unsustainable. A production system might be unsustainable because of: inefficient usage of world food resources; adverse effects on human health; poor welfare of animals; harmful environmental effects such as low biodiversity or insufficient conservation; unacceptable genetic modification; not being “fair trade” in that producers in poor countries are not properly rewarded; or damage to rural communities. Any of these inadequacies could result in the quality of the product being judged as poor.

Animal welfare and other aspects of sustainability are better than the average in animal production when pigs exploit woodland. Agropastoral combinations of soya or other crops and cattle can also have various benefits. Three layer plant production, including pasture, shrubs with edible leaves and trees that may also have edible leaves are an example of a silvopastoral system. The production of leaves and other material that can be eaten by the animals is much greater than can be achieved by pasture-only systems. Results presented from tropical and sub-tropical studies show that cattle production can be better, biodiversity much increased, animal disease reduced, and animal welfare also improved by better availability of shade and other conditions selected by the animals. There are also possibilities for feeding tree and shrub leaves to pigs, poultry or farmed fish.

Key words sustainability, animal welfare, silvopastoral, livestock, disease control

Introduction

Whilst agroforestry has been studied scientifically for many years and some combinations of plant and animal production have continued for centuries, the development of new, truly sustainable systems is urgently needed. Systems were initially called unsustainable when a resource became depleted so much that it became unavailable to the system, or when a product of the system accumulated to a degree that prevented the functioning of the system. Now the meaning of the term is much wider, for example a system can be unsustainable because of negative impacts on human health, animal welfare, or the environment. A definition of sustainability is: a system or procedure is sustainable if it is acceptable now and if its and if its expected future effects are acceptable, in particular in relation to resource availability, consequences of functioning and morality of action (modified after Broom 2001, 2010).

What might make an animal usage system unsustainable? The system might involve so much depletion of resource that it will become unavailable. Alternatively, a product of the system might accumulate to a degree that prevents the functioning of the system. However, any effect which the general public find unacceptable makes a system unsustainable. Members of the public in all parts of the world, particularly in developed countries, are now insisting on transparency in commercial and governmental activities and on changes in methods of producing of various products. A production system might be unsustainable because of: inefficient usage of world food resources; adverse effects on human health; poor welfare of animals; harmful environmental effects such as low biodiversity or insufficient conservation; unacceptable genetic modification; not being “fair trade” in that producers in poor countries are not properly rewarded; or damage to rural communities. Any of these inadequacies could result in the quality of the product being judged as poor. In future, consumers are likely to demand that sustainable systems are used. If they are not, retail companies, production companies and countries that do not produce good quality, sustainable products are likely to be boycotted and hence forced to change (Bennett et al 2002, Broom 2014).

Welfare is the state of the individual as regards its attempts to cope with its environment (Broom 1986) so can be measured scientifically. Measures of animal disease are often important because health is a key part of welfare. Other measures, for example of behaviour, physiology, immune system function, body damage, etc. are described by Broom (2014) and Broom and Fraser (2015). The welfare of animals kept on pasture-only systems can be poor because of heat-stress, parasitic and other infectious disease and low nutrient availability with associated competition (Petherick 2005). The welfare of animals in feed-lots is often worse than that of animals on pasture.

Sustainable systems and welfare 1: livestock in woodland

Agroforestry allows the use of spaces or clearings in woodland for livestock. The animal production is additional to woodland production and may have benefits when dung components are utilised by the plants. Animal welfare and other aspects of sustainability are better than the average in animal production, for example when Andalucian or Portuguese pigs exploit woodland. The trees may be chestnut, oak, etc. and the pigs eat the fruits of the trees, either when these are produced or later.

Agroforestry produces wood, as well as meat or other animal products (Tirapicos Nunes 2007, Santos Silva and Tirapicos Nunes 2013), and often provides an environment that results in good welfare for the animals.

The woodland may itself be made up of trees planted for production of a human resource. For example, in Malaysia cattle can utilise areas between trees in oil-palm plantations.

Sustainable systems and welfare 2: livestock and field crops

Agropastoral combinations of soya or other crops and cattle can have various benefits. However, we have little knowledge of the effects on animal welfare.

Sustainable systems and welfare 3: silvopastoral three layer systems

Three layer plant production, including pasture, shrubs with edible leaves and trees that may also have edible leaves are an example of a silvopastoral system. A cattle production system whose characteristics and aims include: using three-level or other multi-level production of edible plants, managing the soil taking account of worms and water retention, encouraging predators of harmful animals, minimising greenhouse gas emissions improving job-satisfaction for stock-people, reducing injury and stress in animals and maximising good welfare, considering how to encourage biodiversity using native shrubs and trees, and utilising the potential for obtaining wood from trees is explained by Murgueitio et al (2008, 2011), Giraldo et al (2011), Naranjo et al (2012), Broom et al (2014).

The production of leaves and other material that can be eaten by the animals is much greater in silvopastoral systems than can be achieved by pasture-only systems. Results presented from tropical and sub-tropical studies show that cattle production can be better, biodiversity much increased, animal disease reduced, and animal welfare also improved by better availability of shade and other conditions selected by the animals. There are also possibilities for feeding tree and shrub leaves to pigs, poultry or farmed fish. Worker satisfaction is generally high in such systems. The biodiversity may be greater than that in natural forest but some wild species can only be conserved by the use of nature reserves.

The welfare of animals in silvopastoral systems has been demonstrated to be better in various ways than that on pasture-only systems (Table 1 where references are quoted). The beneficial effects of shade are substantial in hot weather with cattle skin temperatures up to 4C lower than in pasture-only systems. High temperature reduces foraging times in paddocks fully exposed to the sun. Anxiety and fear, including fear of humans, can be reduced when partial concealment is possible. The increases in predators lowers the populations of ticks and injurious insects, such as horn flies, and hence reduces the incidence of diseases such as anaplasmosis, which has been shown to drop from 25% to <5%. The presence of nitrogen-fixing shrubs such as *Leucaena* improves animal nutrition and this, together with the better water-retention by the soil, reduces the likelihood of thirst and starvation. Feeding behaviour is

improved at high temperature and humidity if the animals are in a silvopastoral system (Ceballos et al 2011). It may be that the improvement in dietary choice contributes to this beneficial effect (Manteca et al 2008).

Table 1. Summary of benefits of silvopastoral systems for animal welfare.

data from Broom et al (2013)

Nutritional improvement because of shrub and tree intake (Murgueitio et al 2011)

Thermal comfort resulting from more shade (Galindo et al 2013)

Less fear because of concealment (Ocampo et al 2011)

Health better because more predators of ticks and flies (Murgueitio and Giraldo 2009)

Body condition better because of nutrients, shade and less disease (Ocampo et al 2011, Tarazona et al in prep)

Food intake and social behaviour improved (Améndola 2013)

Better human-animal interactions (Mancera and Galindo 2011)

A study of welfare in three intensive silvopastoral systems was carried out in Colombia with *Leucaena leucocephala* and *Guazuma ulmifolia* as shrubs for browsing at more than 8,000 shrubs/ha and several tree species (Tarazona et al in prep). The needs of the cattle were met, there being good food and water availability, effective body temperature control and physical comfort, good social behaviour and low parasite levels. Some respiratory infection occurred on one farm, but this might be expected by chance.

When the social behaviour of cattle was compared in a silvopastoral system and a pasture-only monoculture system in the region of Merida, Yucatán, Mexico there was more social behaviour in total, more affiliative behaviour and less aggressive behaviour in the silvopastoral system (Améndola et al in prep). Social licking was the main affiliative behaviour and head-butting the main aggressive behaviour. The heifers studied showed 46% more social licking but 37% fewer fights in the silvopastoral than in the monoculture system. In the silvopastoral system, 57% of interactions occurred in the shade. Head-butting and chasing occurred in the silvopastoral system but often did not develop into a fight. Social licking is known to occur after the animals have obtained food and shelter (Sato 1991) but it does reduce the heart rate of the participants (Laister et al 2011) and contributes to the stability of social relationships in cattle (Sato et al 1993).

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