

Sustainability of the South African Livestock Sector towards 2050 Part 2: Challenges, changes and required implementations

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Abstract

Challenges facing the livestock sector towards 2050 and the changes and management considerations required to maintain sustainability are discussed. Major challenges are associated with climate change and the environmental impact of the sector. Southern Africa is predicted to become drier and the average temperature may rise by 1.5 °C to 2 °C. Livestock CH₄ emissions are 1330 Gg/year, with enteric fermentation contributing 95%. For commercial production of beef and milk, CH₄ estimates are at the upper half of life cycle assessments of 14 - 32 kg CO₂ e/kg beef and 0.84 - 1.4 kg CO₂ e/kg milk recorded for developed countries. The water footprint depends on production system and efficiency. Global and South African water use estimates for red meat production vary from 80 to 540 L/kg meat. In dairy plants the water usage to process the same product may vary by more than 100%, suggesting scope for improvement. Although animal welfare in South Africa is supported by the Livestock Welfare Coordinating Committee and adherence codes, humane treatment of animals is more difficult to maintain in intensively-housed production systems. Livestock production in communal and small scale sectors requires rapid commercialisation to relieve poverty and contribute to gross domestic product. This requires partnerships, major inputs and paradigm shifts. Input costs including labour increase faster than commodity prices, the concern with labour costs being the impact on employment rates. Efficiency of production should be on par with competitors if the livestock sector is to compete on domestic and export markets. The poultry industry is on par, but rising feed costs, disease and subsidized imports are major concerns. Efficiency in the other industries as measured by off-take percentage is generally lower than competitors, a major reason being lower reproductive rates. In this context, the amount of feed, water and CH₄/kg beef can be reduced by more than 20% if calving rate increases by 20 percentage points. Effective management of rangeland is critical, even more so because of climate change. Livestock production is only marginally competitive and therefore vulnerable to deregulation and trade liberalization. To increase competitiveness exports should increase markedly. For participation in world trade, controlled and notifiable diseases remain a risk. Associated risks are zoonosis and microbial resistance to antibiotics. Stock theft and predation are major concerns. Farmers should employ bio-security measures to ensure the supply of safe products to the consumer. Government and the livestock industries will have to show a clear and strong commitment to address the challenges and opportunities to ensure sustainability of the livestock sector.

Keywords: Challenges, environmental impact, animal welfare, health, commercialization, input costs, efficiency, markets, rangeland, theft, predation, consumer

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Introduction

Livestock production has come under scrutiny because of concerns related to animal welfare, food safety, health, ecosystems and biodiversity (e.g. D'Silva & Webster, 2010). Recently the carbon and water

footprint of livestock has raised further questions (Steinfeld *et al.*, 2006), resulting in calls to decrease livestock numbers and in extreme cases to stop eating livestock foods (Brooks, 2010; www.ciwf.org.uk/) Such drastic interventions will have major impacts on the provision of food and clothing, employment and socio-economic development, the gross domestic product (GDP) and the economic viability of rural towns and associated communities. Some of the arguments are irrational and based on wrong assumptions and information (Capper *et al.*, 2009a), in South Africa mainly, because the correct statistics and associated information are lacking. It is therefore important to define the role and position of the livestock sector in the context of social, economic, food security and environmental impact, to understand its advantages and disadvantages. Only then can the questions be addressed holistically and guidance provided to managers and policy makers.

In Part 1 a thorough overview of the worth and impact of the livestock sector is presented, by providing facts and statistics to establish the current status of the sector. The primary aim of Part 2 is to do an in-depth self-assessment of the challenges facing the sector and how these should be responded to by government, sector support structures, research and development (R & D), and farmers in order to maintain sustainability towards 2050. In addition, wrong assumptions and perceptions are addressed.

Climate change

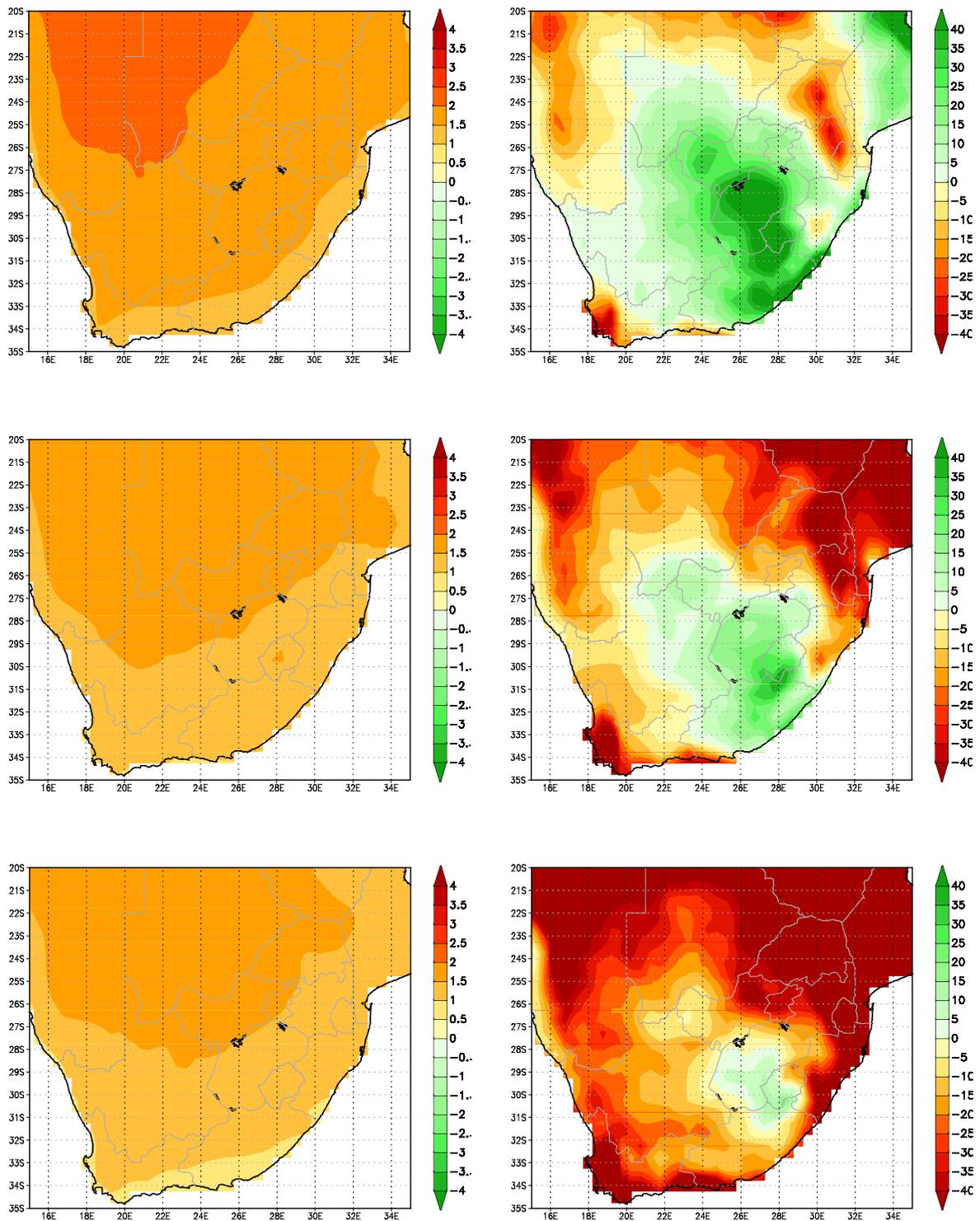
Climate change projections of southern Africa agree that the sub-continent in general will become drier and warmer (e.g. Kruger & Shongwe, 2004; Christensen *et al.*, 2007; Engelbrecht *et al.*, 2009), in accordance with increased greenhouse gas (GHG) emission theory and observations. This has been accepted by government and identified for priority planning in the White Paper on the National Climate Change Response (DEA, 2011). At regional level, for example provincial level climate change responses may differ from the general pattern, requiring projections with acceptable accuracy to advise farmers on temperature and rainfall trends.

The development of the regional conformal-cubic atmospheric model (CCAM) has enabled projections to be performed at resolutions of 200 km, and even 60 km. This model provides the required accuracy with satisfactory simulations of annual rainfall and temperature distributions, intra-annual cycles in rainfall and circulation over the southern African region (Engelbrecht *et al.*, 2009; 2011), daily climate statistics, such as the frequency of extreme precipitation events, and the tracks of cut-off lows and tropical cyclones over the region (Engelbrecht *et al.*, 2012; Malherbe *et al.*, 2013). Using the regional CCAM procedures, probable changes in annual average temperature and rainfall for the period 2021 - 2050 relative to 1961 - 1990 were projected (Figure 1). The period 1961 - 1990 was used as baseline as projected changes at the time were negligible.

The projections show increases in average temperature of 1.5 °C to 2 °C, ranging from 0.5 °C at seaboard to 3 °C in eastern Namibia and western Botswana if the 10% and 90% percentiles are taken into account (Figure 1). Rainfall projections confirm earlier work of a generally drier southern African region, except for the central interior regions and the Eastern Cape, where a wetter rainfall future is predicted. The most significant rainfall reductions - more than 40 mm/annum - are predicted for the eastern parts of Limpopo and Mpumalanga, the south-western Cape and the Cape south coast.

The higher predicted temperatures may result in heat stress in livestock during times of the day that may not be accommodated by behavioural adaptation, resulting in lower productivity. The high producing dairy cow in particular is vulnerable (West, 2003; Bernabucci *et al.*, 2010), but cows on pasture systems of the south-eastern seaboard may not be affected significantly, whereas cows in the interior may face heat stress more often. Heat stress has a number of other longer term implications, including effects on farming system, species and breed choices (Rust & Rust, 2013; Scholtz *et al.*, 2013b).

Water shortages may be more regular in future in the south-western Cape. Because it is a winter rainfall area, the cold-wet spells moving north-east on the seaboard could be reduced towards 2050, resulting in less water availability for livestock requirements and irrigation of winter pastures. Better water storage and management will be required in these regions. This also applies to the interior and the Eastern Cape where the higher rainfall is predicted to often occur in heavy storms and therefore increased runoff (Engelbrecht *et al.*, 2012).



For both temperature (left) and rainfall (right), the 90th percentile (upper panels), median (middle panels) and 10th percentile (lower panels) are shown using the downscaling techniques of the CCAM model. The projections are according to the A2 SRES scenario as defined by the International Panel on Climate Change (IPCC), meaning that no reductions in greenhouse gas (GHG) will occur, that is, the worst case scenario.

Figure 1 Projected change in average annual temperature ($^{\circ}\text{C}$, left) and annual total rainfall (mm, right) over southern Africa, for the period 2021 - 2050 relative to 1961 - 1990.

Environmental impact

Resource management and greenhouse gas emissions

All food production systems have an environmental impact. Livestock production has been singled out as a major cause of climate change (global warming) (Steinfeld *et al.*, 2006), pollution, damage to ecosystems and reduction in biodiversity (WWF, 2010). The effect of livestock on global warming is potentially huge as it is associated primarily with their methane (CH₄) emissions. Methane has a warming potential 21 - 23 times that of carbon dioxide (CO₂) (Taviv *et al.*, 2007; Neem Biotech LTD., 2009) and its effect on the formation of black carbon is particularly significant. Black carbon is an intense heating agent associated with the melting of ice masses and the production of tropospheric ozone (Wedderburn-Bisshop & Pavlidia, 2011).

Political, media and consumer perceptions of livestock's influence on climate change are often simplistic and based on misconceptions, lack of knowledge and wrong calculations. One example of misconception is that low input systems are the key to sustainable production of more food from a dwindling resource. This obviously defies the First Law of Thermodynamics. Thus, 'traditional' production systems (Scollan *et al.*, 2010) and even organic systems with all the perceived accolades for environmental impact, cannot meet the objective as they are mostly low output. At least four studies in the US on milk production confirmed this (Capper *et al.*, 2009a), production being 15% - 27% lower in organic systems than in conventional ones. In addition, when differences in productivity were accounted for, the organic systems required more resources (land, feed, water, etc.) per unit of milk and the environmental impact was greater. Modern conventional systems require fewer resources and have less environmental impact than older (lower input) conventional ones. In 2007 beef production systems in the US (Capper, 2011a) required 69.9% of the animals, 81.4% of the feedstuffs, 87.9% of the water and 69.0% of the land to produce one billion kg of beef compared with 1977, and waste output was reduced to 81.9% manure, 82.3% CH₄, and 88.0% N₂O. A corresponding study for dairy production systems reflects the same principle (Capper *et al.*, 2009b).

Ideally, the resources required and the environmental impacts (the negatives) should be considered in relation to what livestock is kept for as a trade-off, that is, its contribution to food security, sustenance and the economy (the positives). This provides a baseline when applying mitigation options and a comparable means of studying mitigation progress with time, it facilitates comparison of production systems within countries and across the globe and it is a measure of efficiency. In Table 1 CH₄ emissions of South African livestock are given in absolute terms (Du Toit *et al.*, 2013a; b; c; d), in relation to amount of product produced (food, clothing, etc.) and in relation to the contribution to GDP (DAFF, 2010). The CH₄ emissions include emissions from enteric fermentation and manure.

Of the total CH₄ emissions of about 1330 Gg/year (Table 1), enteric fermentation contributes 95%. In previous calculations for South Africa, livestock accounted for about 60% of total agricultural CO₂ emissions (Blignaut *et al.*, 2005; Taviv *et al.*, 2007; Otter *et al.*, 2010), whereas the average contribution of agriculture to total CO₂ emissions in 1990, 1994 and 2000 was about 8.5% (DEAT, 2009). This compares with 5.8% for the USA (US EPA, 2009), 4% for the UK (Scollan *et al.*, 2010) and 6.3% for Austria, 5.3% for the Czech Republic, 6.3% for Germany and 8.8% for Poland (Exnerová & Cienciala, 2009), all lower than the recent calculation of 10% - 12% for the globe (IPCC, 2007) and the earlier figure of 18% (Steinfeld *et al.*, 2006) perceived to be the contribution of livestock to global warming. There may be a number of reasons for the large discrepancy between these figures and the IPCC estimates: The 18% estimate includes deforestation and land-use change, which if subtracted brings the estimate to 14%. In developing countries agriculture accounts for a high proportion of GHG emissions since they are not industrialized and their production systems are not intensive. In intensive ruminant production systems less CH₄ is produced (Capper *et al.*, 2009b; Capper, 2011a) than in systems based exclusively on rangeland.

The CH₄ figures per kg product partly reflect the amount of product produced in relation to the number of non-producing animals. For beef cattle, sheep and goats the proportion non-producing animals (cows, ewes, etc) are high compared to dairy cattle where the cow is also the producing animal. In sheep and goats if wool and mohair are added to meat, the ratio is improved and more so if the CH₄ emission is calculated in relation to GDP, because of the high monetary value of these products (Table 1). The favourable contribution to the GDP figure of game species is mainly the result of revenue of live sales of rare species and tourism.

Greenhouse gas emissions in kg CO₂ equivalent (e)/kg product in life cycle assessments for developed countries (De Vries & de Boer, 2010) are: beef = 14 - 32, pork = 3.9 - 10, chicken = 3.7 - 10, eggs = 3.9 - 4.9 and milk = 0.84 - 1.4. In comparison the CO₂ e figures of CH₄ emissions in Table 1 plus emissions from

grass burning, slaughtering and processing for beef are 25 - 35 kg CO₂ e/kg. For milk the corresponding figures are 1.3 - 1.5 kg CO₂ e/kg. This suggests that in commercial systems South African life cycle emissions to produce these products result in a carbon footprint of similar order, albeit at the higher end of the scale.

Table 1 Methane emissions of livestock (Gg/year) and in relation to kg product produced^(a) (g) and R1000 contribution to GDP^(a) (kg)

Category		CH ₄ emission		
		Gg/year	g/kg	kg/R1000
Beef cattle	Commercial – cows, heifers etc. on rangeland ^(b)	527		
	Commercial – feedlot	30.2		
	Commercial: total: beef and veal	557	707	42.3
	Communal/small scale ^(c)	276	-	-
Total beef cattle		833		
Dairy cattle: milk		130	49.9	14.3
Sheep: mutton, lamb, and wool	Commercial	151	853	39.1
	Communal/small scale ^(c)	15.8	-	-
Goats: meat and mohair	Commercial	18.0	1027	35.0
	Communal/small scale ^(c)	22.7	-	-
Game ^(d) :	Products, hunting, translocation, ecotourism ^(e)	132	-	19.1
Pigs: pork ^(f)	Commercial	7.64	-	-
	Communal/small scale	0.23	-	-
Poultry: meat and eggs ^(f)		3.28	-	-
Horses, donkeys and mules		6.52	-	-
Ostriches ^(f)		8.00	-	-
Total		1 328		

^(a) 2008/9 figures (DAFF, 2010); ^(b) Beef cattle include all categories, also those that are fattened on rangeland; ^(c) Figures of CH₄ per kg product and per R 1000 GDP are not available for communal/small scale sector livestock entering the market; ^(d) Du Toit (2007); ^(e) The source (ABSA Group Economic Research, 2003) mentioned that the value of ecotourism is about 50% of the value of game revenue; ^(f) CH₄ emissions are too low to calculate realistic figures per kg product and per R 1000 contribution to GDP.

Agriculture in committed countries, as all other sectors, is obliged to reduce GHG emissions under the commitment protocol signed at the Kyoto Meeting (1997) of the United Nations Framework Convention on Climate Change (UNFCCC) (unfccc.int/Kyoto_protocol/items/2830.php). In the UK as an example, the required reduction by 2050 is 80% less than 1990 levels, a challenge which their dairy industry is determined to achieve (DairyCo, 2012). Their study calculated the carbon footprint of an across production system farm sample as been 1.3 kg CO₂ e/kg fat-corrected milk. More important though from a mitigation point of view was the variation between farms, from 0.83 kg to 2.8 kg CO₂ e/kg fat-corrected milk, illustrating a vast potential to reduce the dairy carbon footprint. No doubt, this will apply to South Africa as well. The main contribution (66%) to the GHG emissions were factors associated with cultivation, transport, storage, composition and digestion of the feed. Effective GHG emission reductions in feed associated factors include use of home grown forages, energy by-products from the human food chain (for example in South Africa hominy chop, bran, defatted maize germ and brewers grains), feed additives such as oils and monensin, and

within limits the addition of starch to the diet. In contrast, protein sources such as soya and energy sources such as maize have high carbon footprints as they are associated with altered land-use and therefore reduced carbon sequestration (DairyCo, 2012). Other factors associated with reduced GHG emissions per litre of milk include higher milk yield per cow as the emissions attributed to the herd is spread over a larger volume of milk, increased longevity and reduced herd replacement rate, emphasizing the importance of priority attention to herd health and welfare. The close relationship between milk yield per cow, which also reflects intensive vs. traditional systems, is shown for different continents in Table 2 (Capper, 2011b).

Table 2 Average milk yield per cow (kg) for continents and the estimated greenhouse gas (GHG) emissions (kg CO₂ e/kg milk) (results of 2007)

Continent milk	Milk yield per cow	GHG emissions per kg
North America	8 800	1.3
Western Europe	6 100	1.5
Oceania	4 400	1.6
Eastern Europe	3 900	1.6
Russian Federation	3 000	1.7
South East and East Asia	2 800	2.1
Central and South America	1 700	3.3
Near East and North Africa	1 300	3.7
South Asia	1 000	4.7
Sub-Saharan Africa ^(a)	250	7.6

(a) Excluding South Africa.

Corresponding milk yields for South Africa in 2007 were 4 590 kg/cow for cows not in milk recording and 6 950 kg/cow for cows in milk recording (Scholtz & Grobler, 2009). Through interpolation in the relationship in Table 2, GHG emissions could be 1.4 - 1.6 CO₂ e/kg milk, which correspond with the figures estimated before. The concern though is the low participation of dairy farmers in milk recording (20% of commercial farmers – Scholtz & Grobler, 2009) and the dispute in the dairy industry which is clouding participation, since the support given to farmers reflects in increased yields.

Biomass burning

The relationship of biomass burning in the context of rangeland management and GHG emission warrants specific comment. Fire has been associated with maintaining the grass cover in the grassland, woodland and savanna biomes by preventing successional development beyond the grassland stage to thicket (Tainton & Hardy, 1999), and has been instrumental in the evolution of climax grasslands in the humid higher-lying eastern regions of South Africa and those rangelands that would otherwise have evolved to forest or savanna (Tainton, 1999). As a result, burning in the dry season has become an accepted and valuable tool to manage rangelands in the country for pasture-based livestock production systems.

Before human intervention, fires resulted primarily because of lightning with much less frequency than the regular burning done by farmers. Such fires and those associated with clearing for agriculture and deforestation in the tropics and sub-tropics are increasing (Fearnside, 2000) with significant contributions to global atmospheric and ecosystem changes. Biomass burning releases carbon into the air from the burnt material and indirectly through the residual decaying material and from the exposed soil (Fearnside, 2000; Mouillot & Field, 2005). Part of this carbon is in the form of the dangerous black carbon (Ito & Penner, 2005) defined earlier (Wedderburn-Bisshop & Pavlidia, 2011). Biomass burning also has long term effects, since every fire influences the ecosystem carbon budget for many years as a consequence of internal reorganization, decomposition of dead biomass and regrowth (Mouillot & Field, 2005). In addition, the carbon budget is negative as the carbon lost is only partially recovered in regrowth of the vegetation

(Stringer *et al.*, 2012). Apart from carbon release, biomass fires are an important source of air pollutant emissions and constitute a significant factor controlling the interannual variability of the atmospheric composition (Schultz *et al.*, 2008). These fires, furthermore, affect phosphorus fluxes across the globe (Mahowald *et al.*, 2005), sometimes in a negative way as in the Amazon Basin.

In view of the overwhelming evidence that regular and indiscriminate burning of rangeland has unwanted environmental effects, this practice as a management tool should be limited. As alternative, livestock farmers should emphasize the measures described in the section on ***Rangeland and pasture management*** (below).

Effluent from abattoirs and dairy factories

Water quality in water courses and major streams is deteriorating at an alarming rate as effluent from mines, sewerage systems and other sources are discharged almost at will because of ineffective policing. Effluent discharge from abattoirs and dairy processing plants is potentially a major source of pollution because of the huge amounts of water used in cleaning and processing.

Water intake (meaning water brought into the system) and usage in abattoirs and dairy processing plants, and targets were documented in 1989 (Steffen *et al.*, 1989a; b; c). At the time it was calculated that dairies consumed 4.5 million m³ per annum of which 75% - 95% was discharged as effluent. To limit effluent specific targets were set for the manufacture and packaging of individual products. The targets regarded as realistic were 60% to 75% lower than consumption. Red meat abattoirs consumed 5.8 million m³ per annum with a specific water intake of 1.36 to 2.04 m³/cattle unit. Waste-water volumes discharged were 80% - 85% of water intake which allowed targets to be set at 1.1 m³/cattle unit for large abattoirs and 1.75 m³/cattle unit for small abattoirs. Poultry abattoirs used 6 million m³ water per annum, with a specific water intake of 17 to 20 L/bird. Targets set were 15 L/bird for A-grade abattoirs and 20 L/bird for other grades. Targets were also set for Specific Pollution Load (SPL) and Chemical Oxygen Demand. For SPL, targets were set at 29 g COD/bird and 7 g Specific Solids/bird for A-grade abattoirs and 64 g and 14 g respectively for other abattoirs.

It is not known whether the targets set for abattoirs and dairy processing plants are still appropriate or should be revised. If more recent figures for dairy processing are considered (Jonker, 2011 pers. comm.), it appears that some processors either do not know about the targets or do not strive to adhere to them. The water used by different dairies vary between 2.0 and 3.2 L water/L UHT milk, 10 and 27 L water/kg semi-hard cheese, 15 to 20 L water/kg milk powder and 7 to 10 L water/kg yogurt. The high levels obviously will have major effects on effluent discharge and must be addressed urgently to support future sustainability.

Waste/pollution

The need to limit or eliminate pollution applies to all systems, whether they are poultry systems which produce nitrous oxide - that has 298 - 310 times (Taviv *et al.*, 2007; Neem Biotech LTD., 2009) the global warming potential of CO₂ - or manure systems of piggeries and intensive dairy farming systems. Manure should preferably be collected in covered dams or lagoons to reduce CH₄ and/or treated in anaerobic digesters. Following treatment the solids can be used as organic fertilizers to the benefit of soil flora.

There is a perception that manure in beef cattle feedlots is a large source of pollution (NRDC, 2013) which is not the case since it dries quickly in the sun when stacked, thereby producing little effluent and CH₄ because the manure is aerobically degraded (IPCC, 1997; Australian National inventory Report, 2009). Manure management in feedlots and other large operations nevertheless requires commitment as there are concerns that residues of antibiotics and veterinary drugs, as well as food borne pathogens such as *E. coli* and *Salmonella* strains may pollute drinking water and enter the food chain (Holtslander, 2007; NRDC, 2013).

Anthropods can be used to break down abattoir and other waste and turn these products into an asset (Pieterse, 2013). Addition of the larvae and pupae of these anthropods to broiler diets formulated on an iso-energetic and iso-nitrogenous basis, to replace soybeans and fishmeal, resulted in similar and improved production outcomes. In addition, the production potential of larvae far outstrips that of other protein sources, showing protein productions up to 1000 times per hectare more than other sources. Such initiatives should be encouraged and commercialised.

Animal welfare and health

Animal welfare can be defined as a reflection of people's concern for the humane treatment of animals. There are international guidelines on the care and use of animals in livestock practices on farms, in transit, in sale yards, in feedlots, and in intensive housing systems such as for pigs and poultry. Categories that require special attention are (RPO, 2010): the recognized "five freedoms" which provide valuable guidance in animal welfare management; the use of animals which carries a duty to ensure their welfare to the greatest extent possible; and improvements in livestock care which often enhance productivity and have economic benefits. There are many examples: the animal that does not bruise when in transit because of well-designed transport equipment; the quality and shelf life of meat improve with humane handling practices; and losses are minimized and the efficiency of production improves if stress and disease are controlled.

In South Africa maintenance of livestock health and well-being is supported by several Acts and pieces of legislation (DAFF, 2003):

Animal Diseases Act, 1984 (Act no 35 of 1984);

Animal Identification Act, 2002 (Act no 6 of 2002);

Animal Improvement Act, 1998 (Act no 62 of 1998);

Animal Protection Act, 1962 (Act no 71 of 1962), and

Fertilizers, Farm Feeds, Agricultural Remedies and Stock Remedies Act, 1947 (Act no 36 of 1947 – currently under revision).

In addition, Codes of Practice were developed by the Livestock Welfare Coordinating Committee (LWCC) of the Department of Agriculture, Forestry and Fisheries (DAFF) (RPO, 2010) and industry support bodies. These include:

- Code for Abattoir Managers and Superintendents;
- Code for Feedlots;
- Code for Handling and Transport of Livestock (a similar one specifically for ostriches);
- South African Pig Welfare Code;
- Guideline for the use of Prodders and Stunning Devices in Abattoirs;
- Code of Practice for the Handling of Livestock at Sale yards and Vending Sites.

All animal care legislation is being reviewed to accommodate animal rights with the intention of consolidating these into one manual on animal care (SAVF, undated).

Worldwide concern for animal welfare is increasing. The livestock sector, with all supporting measures discussed above, agrees that the humane treatment of animals is a cornerstone of civilisation. The challenge for all farmer-support bodies and other institutions in the industry is to ensure that their members adhere to the acts, codes and guidelines.

Often concern for animal welfare is a plight for animal rights (Johnsen, 2009), which is a sensitive issue and where activists often have dubious agendas (Animal Agriculture Alliance, 2012). Animal rights are defined in the context of human emotions and perceptions which make objective evaluation difficult. The focus of animal rights activists is primarily on intensive housing systems of pigs and poultry, accepting that these practices are inhumane. An objective measure of animal welfare is efficiency. If feed efficiency is negatively affected in optimally fed and watered animals there may be indications of stress or disease, which reflect on welfare. Internal control and management should be meticulous and guided by support bodies through continuous communication and technology transfer. Likewise some guidelines of animal rights are of value and practical and should be implemented. For example poultry housing and piggeries should not be unduly intensified and sows should not be kept in farrowing crates after the first eight weeks of pregnancy.

Commercialisation in the small scale and communal categories

The South African livestock sector is characterized by a dichotomy between well-established farmers and subsistence farmers which are largely poverty stricken. Between these poles there are farmers in transition towards becoming established and self-supporting. These categories of farmers are defined in a particular way according to history and to provide a specific focus for intervention strategies. This warrants some detailed explanations.

Subsistence farmers are also referred to as communal farmers, this definition referring to the structural arrangement within which they operate. Subsistence agriculture is the oldest system and the only system of

Africans during colonization. At the time almost every household kept livestock and every villager had the right to keep livestock in consultation with the traditional leadership (MacKinnon, 1999; Turkson, 2003), but they did not own land. The main feature of this dispensation is that livestock graze common lands that are managed loosely under traditional leadership. Owners bring their animals in at night and herd them during the day under commonage. Individual herd and flock sizes range from one to several hundred (Scholtz *et al.*, 2013c). The small units can be referred to as “owner”, “keeper” or “holder” as “farmer” implies a commercial intent or venture, which the majority do not have.

Farmers in transition, also defined as small-scale or developing, are individuals who were previously excluded from active participation in the farming business and now farm on property that is either leased or purchased with or without government support. Some of these farmers have accumulated wealth from other business sectors or are professionals. Some had livestock in the communal dispensation which they have shipped to their newly acquired farms; others had to purchase their animals. Farmers in this category are included in the low-income group as studies have shown that they make less money than the well-established (commercial) farmers (Motiang *et al.*, 2005). In some cases they are remote or absentee farmers and rely on hired labour for management. They spend their time in other businesses, for example as taxi owners, lawyers, medical practitioners or any other entrepreneurship that generate sufficient income to acquire or run a farm.

The well-established farmers, referred to as commercial farmers, are generally but no longer exclusively white farmers. In this category production is comparatively high, relatively efficient, self-supporting and simulates farming systems in the developed world.

About 41% of cattle, 12% of sheep, 67% of goats, 28% of pigs, 6% of broilers and 9% of layers are owned by the small scale and communal sector (see Part 1: Meissner *et al.*, 2013). The percentages vary from province to province but indicate that every province has a largely untapped resource that can be utilised for commercialization. In Part 1 the benefits of livestock keeping in rural areas were discussed, but there is little doubt that commercialization with market penetration is key to uplifting these communities from poverty. This is also in line with government policy (DAFF, 2003). The challenge, however, requires involvement at different levels.

Land reform is vital for equitable access and participation in commercial farming, with the aim of establishing economically viable units that can ensure sustainable and profitable production. However, land reform must also address the current communal farming dispensation and include arrangements to ensure proper land use. The current system tends to result in conflicts and disagreements on common usage of resources (Nengovhela, 2011), which has a negative effect on commercialization and poverty relief goals in this sector. Land reform strategies should also consider optimal utilization of land use which should prescribe the implementation of extensive or intensive systems, vertical integration and value chain optimization.

New entrants (small-scale/developing farmers) require support services by government in order to commercialize their farming enterprises. These can be grouped into structural, financial and market access (DAFF, 2006). Structural refers to organization at the national and provincial level which provides policy guidelines and a supportive national and international market environment. It also refers to structures such as commodity organizations and support bodies that operate in conjunction with government to be of use to the producer at macro level, providing technical assistance, market information and guidance. Financial support is the cornerstone of any commercial enterprise. At present, the majority of livestock owners are not able to access sufficient funds due to a number of reasons, the main one being land ownership as basis of equity. They also lack financial management skills. Market access first and foremost requires excess stock that can be sold, thereafter skills and experience will develop through the formal, recognized marketing channels (Scholtz *et al.*, 2013c).

Effective commercialisation also requires partnerships. The livestock sector is still faced with the dualistic system of those who engage actively in the formal marketing channels, which are the commercial farmers and those on the fringes of the formal marketing channels (small-scale farmers). Small-scale producers remain open to exploitation by the system due to lack of knowledge of market conditions, pricing structures and marketing opportunities (Scholtz *et al.*, 2013c). This is partly because of fragmentation in the livestock into different support bodies which should be addressed since all producers whether large or small, pursue the same goals. One consolidated support body could ensure that the knowledge and experience of all livestock farmers become common property to the benefit of all, especially the small-scale farmers. In

addition, skills development and mentorship driven by the support bodies are vital but in the longer term active partnerships to assist small-scale farmers towards economic empowerment should be pursued.

Adaptation and sustainable profitability

Input costs

Production inputs are many and varied in the livestock sector and the costs of some cannot be controlled by the livestock farmer. Any livestock enterprise has a minimum labour requirement depending on the degree of mechanisation and intensity of operation. More intensive enterprises (poultry, abattoirs, and eco-tourism) in general require more labour even though their output is characterized by low returns per unit. They therefore rely on turnover. Labour cost through union pressure, supported by labour and minimum wage legislation has become a significant constraint (DAFF, 2006), even more so for small-scale/developing farmers. This is aggravated because employees are by and large unskilled or low-skilled. On the positive side, it provides the opportunity of training and mentorship which improves the competitiveness of trainees in the labour market.

The rate of change in input costs is more than the rate of change in producer price of livestock products, resulting in a narrowing of the ratio between input and output. This has been particularly noticeable since 2000 (DAFF, 2010) (Table 3).

Table 3 Indices of producer price of livestock products and farming requisites for 1979 to 2009

Year	Producer price index	Farming requisite price index
1979	8.9	6.8
1989	34	27
1999	62	60
2004	98	99
2009	156	167

The disparity in index elevation puts pressure on profitability and sustainability, compromising the effort of new entrant commercial farmers to become successful. Some unfavourable trade agreements and policy decisions impact directly on the relationship between input costs and product prices (DAFF, 2006) and should be revised. This does not imply that the market has to be manipulated with set floor prices as in the past, but the farmer needs some assistance to limit risk. If not, the ability to survive will be jeopardized and as a consequence the ability to promote employment, rural economic development, food security and stability as envisaged since 1994.

The cost of capital is usually high, although the recent worldwide downswing in the economy resulted in the Reserve Bank lowering interest rates. The high cost affects production inputs. Furthermore, turnover in extensive production systems is slow, thereby profitability is directly affected. Capital cost is often low in competitor countries, allowing them more manoeuvrability in pricing for domestic and international markets (DAFF, 2006). Another concern is the practice of subsidization by competitor governments to support farmers when entering the markets to encourage export. These elements impact on the competitiveness of livestock farmers in South Africa as their products have to compete with subsidized products coming onto our supermarket shelves.

Efficiency of production

Efficiency of production should be on par with competitors if the livestock sector is to hold its own in the domestic market and even better if export is envisaged. Secondly, if efficiency is optimal, land use and resources are optimized and the carbon and water footprint reduced. In order to improve efficiency all input variables (natural resource base, financial arrangements, human resources, inputs, skills, abilities and other factors such as social concerns) will have to be harnessed in support of biological measures in such a way as

to ensure that the end product is the result of efficiency at all levels. Efficiency of production can be measured in various ways, ranging from biological (off-take, feed efficiency) through sustainability of production to simple economical returns. The challenge is to achieve maximum economical returns through optimal biological production efficiency and maintaining long-term sustainability at the same time. Biological efficiency is arguably the most critical factor as it is partially under control of the farmer.

One way by which biological efficiency can be evaluated is through percentage off-take or slaughter rate. In Table 4 off-take percentages of beef cattle, sheep, goats and pigs in South Africa are compared with off-take percentages in other countries and regions. Since parent stock does not enter the equation, biological efficiency in broilers cannot be calculated in this way. The most efficient manner for broilers (and layers) is the amount of feed required per unit product, and at 1.8 - 2 kg/kg chicken meat the South African broiler industry compares favourably with the best in the world. The Achilles heel of the poultry industry is rising feed costs (SAPA, 2010a; b) and disease.

Table 4 Off-take percentage of different species in South Africa compared with other countries and regions (FAOSTAT Database, 2002, unless indicated otherwise)

Country and Region	Beef cattle	Sheep	Goats	Pigs
South Africa (commercial)	23 [32 ^(a) 33 ^(b)]	29 [35 ^(b)]	33	125
South Africa (small scale)	8 ^(c) [25 ^(a) 12 ^{(b)(c)}]	36 ^(d) [2.3 ^{(b)(c)}]	10 ^(e)	51 ^(d)
South Africa (communal)	6 ^(a)			
Australia	28	28	37	186
New Zealand	37	68	79	204
European Union	34	65	72	164
USA	38 [37 ^(f)]	50		170
Brazil ^(f)	22			
Argentina ^(f)	26			
Uruguay ^(f)	30			
South America ^(g)	20	50	30	82

^(a)Scholtz & Bester (2010); ^(b)Spies *et al.* (2011); ^(c)No distinction made between small-scale and communal;

^(d)SAMIC (2003); ^(e)Research and training strategies for goat production systems in SA (1998);

^(f)Scholtz *et al.* (2011); ^(g)Argentina, Brazil, Paraguay and Uruguay.

Off-take in the commercial beef cattle category may have improved if the 2010 (Scholtz & Bester, 2010a; Spies *et al.*, 2011) studies are compared with the 2002 one (FAOSTAT Database, 2002) (Table 4), but there is still room for improvement. The off-take in the commercial sheep and goat category is low compared with some other countries because of the inclusion of wool sheep and mohair-producing goats, where slaughter percentage is low because of the emphasis on fibre production. Compared with developed countries there is also room for improvement in off-take in the pork industry. In comparison with the commercial category there is even more scope for improvement in the small-scale category, whereas the percentage off-take figure in the communal category largely reflects the low access to the market, but also biological factors which require considerable improvement if the communal category is to commercialize. It should be recognized though that it is not possible to measure the off-take in the informal market and home consumption, which would increase figures considerably.

Primary reasons for low off-take are average to low reproductive rates, high mortality and wrong herd/flock composition. For example, calving percentage in the commercial, small-scale and communal categories (Scholtz *et al.*, 2011) is 62%, 48% (30% - 40% according to Spies *et al.*, 2011) and 35% respectively, mortality 5.8%, 5.5% and 35.4% respectively, and percentage adult females in the herd 52%, 49% and 25% respectively; figures which are unacceptable if not dismal, even for the 'advanced' commercial category. Study group results of commercial sheep farming indicate that the position in some

regions of 75% - 80% lambing percentage (Meissner, 2011a) (other regions reported better figures of 93% - 102% [Spies *et al.*, 2011]) and 65% - 70% weaning percentage is probably not much better, although stock theft and predation are significant. The concern is the high variation in reproduction with the seedstock industry showing calving percentages in excess of 90% (versus the national average of 62%) and 140% weaning rate in sheep vs. 102% on average in a case study in the Eastern Free State (Fourie, 2012). These controllable (managerial) factors should become priority for livestock farmers, their supporting bodies and provincial extension. It is easy to calculate the impact on red meat production if the reasons for low off-take are rectified. For example, if calving percentage in the commercial and small-scale sectors can be improved to 70% - 75% (still low compared to international and seed stock figures) and mortalities limited to 3% - 4%, off-take can improve to percentages recorded in the US and New Zealand. South Africa can then potentially become a net exporter of beef; and the commercialization of the communal sector has not even been considered.

Apart from the positive effect on biological production efficiency, and therefore on off-take percentage, the mitigation effect on CH₄ emissions would be substantial. The same applies to water usage. A simplified calculation of the outcome for one year in a 100 cow unit with weaning rates of respectively 60% and 80% demonstrates the concept (Table 5). For ease of calculation and to ensure that the same grazing capacity is maintained during the course of the year, figures in Table 5 were calculated in Large Stock Units (LSU's).

Table 5 Feed use, CH₄ emission and water use of 100 cows weaning 60 and 80 calves respectively and the marketable calves fattened in a feedlot (all measures in ton/year)

ITEM	60%				80%			
	Feed	CH4	Water	Meat	Feed	CH4	Water	Meat
Cows, 110 LSU's	361	30.7	1 805	-	361	30.7	1 805	-
Replacements (25%), 20 LSU's	65.7	5.57	329	-	65.7	5.57	329	-
Weaners to feedlot, 100 days	16.4	1.03	65.6	-	21.1	1.32	84.4	-
Totals	443	37.3	2 200	-	448	37.6	2 218	-
Feedlot production		28 LSU's = 12.6			44 LSU's = 19.8			
Old cows, 23 LSU's		= 10.4			= 10.4			
Total		= 23.0			= 30.2			
Kg feed, CH ₄ , water/kg meat	19.3	1.62	95.7		14.8	1.25	73.4	
Improvement of about 23%								

Assumptions: cow = 1.1 LSU, replacement heifer = 0.8 LSU, feedlot calf = 0.8 LSU; rangeland = 55% digestible, feedlot diet = 80% digestible; CH₄ = 12% of 55% digestibility and 8% of 80% digestibility; water intake = 5 kg/kg feed on rangeland and 4 kg/kg feed on feedlot diet (higher needs on rangeland because of higher maintenance requirement and more water required for digestion and metabolism of fibrous diet); old cows marketed from rangeland.

Table 5 shows that if weaning percentage could be improved from 60 to 80, CH₄ emissions and water use per kg meat produced could be reduced in excess of 20%. The calculations also suggest that for the same output of meat fewer cows can be kept, resulting in a further reduction in CH₄ emissions and water use. Thus, if beef cattle, sheep and goat farmers on rangeland systems strive to improve reproduction and weaning rate, thereby increasing biological efficiency, they will automatically improve the carbon and water footprint.

The increasing trend of farmers not to employ a distinct calving season but to calve through the year, resulting in some cows not calving every year, is cause for concern (Meissner, 2011b) for a number of reasons:

- The calving percentage per year is lower.
- The influence on genetic progress, that is, the culling programme for fertility and the introduction of replacement heifers with better genetics (with no clear yearly records strict selection programmes are difficult, resulting in slower genetic progress). Since the nutritional requirements of cows in late gestation and lactation are much higher than cows not in gestation, the calving season is scheduled to coincide with the time of the year (rainy season) when the rangeland can provide the maximum possible nutrients. With no distinct calving season a number of cows will calve at a time when the rangeland cannot provide, which means that supplementary feed will be required. This increases input costs, risk to the calf because a number of cows never take supplements, and stress on cow reserves which may increase their susceptibility to disease, arthrosis and nutritional imbalances.
- Grazing capacity and stocking rates were designed on the assumption that the requirements of the herd are synchronized with what the rangeland can offer and with the time surplus animals are removed. This is altered with calving throughout the year which means that pressure may be put on the grazing, resulting in overstocking in the long term.
- In the context of the carbon and water footprint: more inputs go into parent stock (cows) and because reproductive rate per year is lower, off-take is lower, which will increase CH₄ emissions and water use per kg meat produced.

From a breeding point of view most of the progress to improve efficiency of production in beef cattle in South Africa has been achieved by a combination of conventional techniques, such as breed substitution, crossbreeding and within-breed selection; the primary tool being performance recording. Performance recording is primarily focused on selection for growth rate as a replacement for feed efficiency. There is evidence though that increased growth rate boosts mature size, thereby increasing the maintenance requirements of the breeding herd (Scholtz *et al.*, 2013b; c), which could be a further reason for the higher incidence of arthrosis observed over the last 20 years referred to above. Alternative traits to lower maintenance requirements and to improve both cow efficiency and post weaning growth efficiency are discussed in this issue (Scholtz *et al.*, 2013a).

Genetic progress has seen vast strides with advances in genome-based techniques and marker-assisted selection (Scholtz *et al.*, 2011; 2013a). The advantages for the South African dairy and beef cattle industry of employing these techniques and genome-based estimated breeding values (GEBV's) have been reviewed recently (Van Marle-Köster *et al.*, 2013). There is no doubt that in order to support sustainability and competitiveness towards 2050 marker assisted selection should be implemented sooner rather than later.

Rangeland and pasture management

Since livestock farming is the only option on most agricultural land, ruminant production systems depend primarily on natural vegetation and consequently farmers have a responsibility to manage the resource sustainably. This implies good understanding of the dynamics and interaction between soil, climate, rangeland and livestock. The statement is even more valid if it is recognized that ruminant livestock farming is also practiced in the more arid regions of the country which receive less than 500 mm of rain per year. In addition, precipitation is seasonal and erratic with a high risk of seasonal, annual and prolonged droughts. Aggravating circumstances are eroded and bare patches in overgrazed areas which promote run-off, resulting in less effective usage of rain water for fodder production. Furthermore, the dry season coincides with winter with low night temperatures that prevent any growth from accumulated moisture, resulting in plant material losing its nutritive value, a challenge in extensive systems. Predictions of climate change indicate even more dry spells and heavy storms with more run-off (Engelbrecht *et al.*, 2009; Malherbe *et al.*, 2013).

Management of the natural vegetation in essence means management of the risks imposed by the environmental variability and constraints. This has two components, viz. conservative planning based on lower than expected rainfall which relates to stocking rate, and provision of extra fodder for the periods when the rangeland provision is inadequate. An associated aim must be to conserve the plant and soil resource for future generations. Farmer dedication to rangeland protection and restoration (RPO, 2010) must be to:

- restore the loss in basal cover and key climax and palatable species;
- address bush encroachment and invasion of alien species;
- employ conservative stocking rates, aligned with regularly monitored grazing capacity, and

- prevent soil erosion and recover eroded patches by natural and mechanical means.

Where vegetation resources are limited and/or overgrazed the fodder supply should be supported by cultivated species. Drought tolerant species such as *Atriplex* and *Opuntia* spp. should be established in regions susceptible to seasonal, annual and prolonged droughts, *Anthehora*, *Cenchrus*, *Panicum*, *Digitaria* and *Eragrostis* spp. are choices in the western, northern and north-eastern grass biomes of the country, whereas various high yielding grass and legume species should be considered in high rainfall regions and the southern and eastern seaboard. Farmers in general do not adequately utilise such fodder crops which make their operations and the natural vegetation vulnerable.

In their Livestock Development Strategy for 2006 - 2015, the DAFF (DAFF, 2006), acknowledged the importance of the vegetation base for the livestock sector and made provision for a number of far-reaching interventions. A number of the interventions have not materialized. These include: development and implementation of a holistic drought management plan; development and maintenance of a national vegetation database accessible to all stakeholders; conservation and utilization of indigenous and adapted forage cultivars and species; development of policy and legislation for tax relief for infrastructure development such as fencing and watering points to ensure sound rangeland management (of particular importance to small scale and communal farmers); and, introduction and maintenance of a Rangeland and Forage Improvement Scheme with similar objectives as the livestock counterpart.

Furthermore, it has been argued and scientifically justified for some 30 - 40 years that the Eastern Cape (old Transkei area) has high potential for a number of agronomic crops and for the establishment of cultivated grass and legume species, the latter recognized in the Livestock Strategy (DAFF, 2006). If well-planned, livestock production and agriculture in general in this primarily communal farming area could excel, with far-reaching consequences to food security, poverty relief, agricultural GDP and trade. With climate change the introduction of suitable legume species in intercropping systems with grass and agronomic species is even more important to consider. In this region the potential is for establishment by rain-fed systems (almost exclusively), resulting in a low water footprint, and since the legumes can provide the nitrogen instead of fertilizers, also a low carbon footprint.

Animal health and zoonosis

Effective control of highly contagious and notifiable diseases that may harm local stock and international trade relations is expected to become more important than in the past. These include bovine spongiform encephalopathy (BSE), foot-and-mouth disease, African swine fever, avian influenza (AI) and Newcastle disease, all of which have a negative effect on regional and international trade. Regular outbreaks in South Africa and border threats from neighbouring countries have had major impacts on livestock movement, slaughterings and income. Border and fence control, Office International des Epizooties (OIE) requirements, vaccination programmes, regular sampling for notifiable diseases such as brucellosis (CA) and tuberculosis (TB), dealing with game species diseases that affect livestock, and continued support of the Agricultural Research Council's Onderstepoort Veterinary Institute (ARC-OVI) and Onderstepoort Biological Products (OBP) to ensure appropriate and timely vaccine development and production are paramount (SAMIC, 2002).

The problem of suboptimal control is general in the developing world because of lack of resources. This results in developing countries often being excluded from the world trade in livestock products to the detriment of development. Some of the standards imposed by the OIE may possibly be too stringent as with certain diseases there is no threat to animal health with commodity-based world trade, since food safety standards on commodities can be employed effectively (Thomson *et al.*, 2004; Rich & Perry, 2011).

The threat of disease will increase since climate change is expected to be instrumental in the emergence of new diseases and the spread of diseases that have been unknown or whose occurrence is rare in particular regions (Summers, 2009). These are mostly vector-borne diseases with bluetongue and Rift Valley fever (RVF) re-emerging (OIE, 2008). It is therefore worrisome that with the recent outbreak of RVF farmers appeared indifferent to vaccination, resulting in major losses, despite commitment to their respective Codes of Best Practice which provide directives.

Zoonosis (livestock diseases affecting human health) (Greger, 2010) and insufficient hygiene measures are of concern, particularly in communal, peri-urban and other informal settlements, also because they affect food safety in general (Oliver *et al.*, 2009). Zoonosis is correlated with the expansion and intensification of livestock production. It is apparently related to multidrug resistant bacteria, where the mass

feeding of antibiotics as growth promoters is thought to be a contributing factor (Greger, 2010). The antibiotic resistance issue has turned highly emotional and is further incited by a campaign of disinformation (Meissner, 2012b). Although current evidence does not support a direct relationship between antibiotic use or overuse in animals and microbial resistance (National Institute of Animal Agriculture, 2011) the threat of resistance cannot be ignored. Therefore, responsible use of drugs, effective control by authorities and drug companies, and prescriptions only by properly trained individuals are pivotal to preventing resistance. In the research and development (R & D) domain increasing emphasis should be put on finding alternatives to in-feed antibiotics. Much progress have been made to replace antibiotics with direct-fed microbials (DFM's) (Krehbiel *et al.*, 2003), with probiotic DFM's to limit shedding of the food pathogen *Escherichia coli* O157:H7 during feedlot finishing (Elam *et al.*, 2003), and with DFM's and enzymes to improve gut health and performance of poultry (Plumstead & Romero, 2013).

In general, ascites and diseases associated with gut health in the poultry industry and tuberculosis, brucellosis and leucosis in the beef and dairy industries remain threats. Because a high proportion of milk tested in the country still shows somatic cell counts (SSC's) of 300 000 cells per mL or more, this should be a concern for the dairy industry.

Crime and predation

Crime, including stock theft, has reached unacceptable levels in the farming and rural communities. A study in the Eastern Cape has shown that the loss due to stock theft amounted to R 600 million per year which is about 20% of the GDP of agriculture in the province (Anthrobus, 2002). Stock theft may be higher in the communal sector than in the commercial sector (Anthrobus, 2002; Scholtz & Bester, 2010b), which is worrisome.

Crime has a direct bearing on the emotional, economic and social well-being of farming and associated communities, and it affects the economic viability of towns since their businesses are largely farmer dependent. The police and supporting structures have not been highly effective, which necessitates community involvement through networking, patrolling and open communication channels to the South African Police Service (SAPS).

Predators such as jackal, leopard and caracal in natural systems or reserves are important in controlling population numbers and removing sick and old animals and decaying carcasses. Unfortunately, calves and small stock in the vicinity are easy targets resulting in enormous losses per year. In one investigation the loss was estimated as being 8% of all stock losses. In a structured survey in the Western Cape a figure of R 105 million per year was obtained which covers only the direct cost (Van Niekerk *et al.*, 2010). The most recent report estimates the loss for the small stock sector in five provinces as being about R 1.3 billion (RPO News, 2012). The problem is aggravated by the practice of hunting with dogs and stray dogs killing livestock. These losses obviously have major implications for the economic sustainability of the farming enterprise, agricultural GDP, export of wool and mohair and domestic meat supply.

Efforts by farmers to protect their stock by killing marauding predators have been met by emotional protests from misinformed wildlife advocates and the public at large, resulting in the issue becoming a major welfare debate. Until recently the debate has been characterized by mud-slinging which is not conducive to finding amicable solutions. It is therefore praiseworthy that stakeholders decided to work together by establishing the National Damage Causing Animal Forum of South Africa (RPO News, 2011) and initiating projects towards finding solutions. The challenge, however, remains enormous.

Markets, import and export

Livestock sector marketing operates mainly through supply and demand as input costs cannot be controlled. In addition, deregulation and trade liberalization have had significant effects on agriculture in South Africa. For the livestock sector probably even more so (NAMC, 2001; CIAMD, 2002) because, in comparison with a number of agronomical and horticultural commodities, the livestock sector is only marginally competitive (Esterhuizen *et al.*, 2002). The challenge is to find a balance between affordable and acceptable livestock-based products for the consumer, maintain and create job opportunities, develop and empower the small-scale and communal categories, and increase competitiveness in the domestic and international markets.

Demand for livestock products is determined by price, quality, availability and convenience, acceptability, price of alternatives, perceptions about safety, health and nutritional value, social and cultural

preferences, diversity and general wealth of the consumer (DAFF, 2006). The challenge in marketing is to deliver the right product at the right time at the right price to the consumer – the production and value chain approach is therefore primarily consumer driven. The focus on demand is still not well understood by many and therefore opportunities that arise in the market are often not spotted and exploited.

With trade liberalization international markets became more accessible to South Africa and South African markets also more accessible to many countries that have a competitive advantage. The principle is sound because the consumer should have the benefit to buy a diversity of products at affordable prices – even more so because of the food security argument in rural and peri-urban areas. Governments should have the means to reduce inflation and create favourable conditions for employment. Free trade agreements (FTA's) have particular advantages and competition promotes efficiency. The proviso is that the playing field should be level and fair.

Some trading partners from which livestock products are imported, mostly developed countries, pay subsidies to their producers and export refunds are often paid, thereby creating a distortion in the market. In 1998 only New Zealand (0.8%) had a lower Producer Support Estimate (PSE) than South Africa (2.7%). The PSE of the European Union, which is a major trading partner, was as high as 45% (CIAMD, 2002). The distortion is expected to remain.

Because the playing field is not level, it is justifiable to protect the local industry through measures such as tariffication, as sanctioned by the World Trade Organisation (WTO), but tariffs should not serve the purpose of isolating industries from international competition. Tariffication should stimulate balanced trade. What should not be tolerated, though, is dumping on South African markets, which is regularly experienced by the broiler industry, and unscrupulous importers that abuse the tariff system by under-invoicing in order to pay a lower tariff. The estimated loss in tariff income on the importation of red meat amounted to R50 million per year (NAMC, 2001), but counteracting measures have since borne fruit (CIAMD, 2002).

Free trade agreements have several advantages, but should be considered carefully. For instance, the export capacity of the trading partner should be taken into account. In this context the FTA with MERCOSUR remains of concern as the size, cost structure and large export potential of their red meat industry can result in price changes in the long run that can hurt the local industry (NAMC, 2001).

A major challenge for the livestock sector is to increase its share in the export market through concerted pursuit of opportunities that arise. Export brings foreign capital into the country and it correlates with competitiveness. By being more competitive investments increase, concerns about imports diminish and the sector can put scarce human and capital resources to better use in the country (NAMC, 2001). However, as the livestock sector primarily is only marginally competitive in the global market (Esterhuizen *et al.*, 2002), and since the share of livestock products in the total agricultural export earnings was a dismal 5% in 2008, the livestock sector is not ready to cash in on the increased demand of the developing world (FAO, 2002; Scollan *et al.*, 2010). Export markets should be pursued vigorously - major challenges being efficiency of production, traceability, food safety measures, supply-chain management, branding and trade mission focus (DAFF, 2006; Meissner, 2012b).

Consumer protection and demand

Access to safe and healthy food by all citizens is a fundamental human right, and endorsed in the Constitution. This assigns particular responsibilities to the entire agriculture value chain, starting with farmers.

For the livestock farmer it is all about control of risk if value-added chain protection of the consumer and quality product assurance are to be guaranteed. Risk control becomes effective when traceability, hazard analysis of critical control points (HACCP) and audit systems are implemented (RPO, 2010). For farmers these are guided by the commodity Codes of Best Practice. Traceability is also 'enforced' by retailers such as the Woolworths Code of Practice for Sheep Production (Woolworths 2009). Traceability and supply chain control measures will probably increase as processors and retailers need to protect consumers and meet their demands which increasingly, apart from food safety and quality, will focus on social, environmental and animal welfare issues.

Some farmers remain indifferent to risk control measures such as auditing (record keeping) and applying the principles of traceability, which is defying their obligation to consumers and in the long run can affect sustainability of their enterprises. Traceability (not compulsory yet) and record keeping can assist farmers in controlling health and safety risks before the farm gate, but they also support communication

down the supply chain, since regular interaction with buyers and retailers becomes necessary (RPO, 2010). Traceability requires identification of all livestock by branding or tattooing and the keeping of records of breeding and husbandry practices, disease and medical treatments, feed sources and compositions, health, safety and contamination (e.g. waste, pollution), and importantly – control of access to the farm or contact with livestock and the work environment. Uncontrolled access to farms can spread disease.

Concluding remarks and future outlook

The socio-economic contribution and growth of the livestock sector are satisfactory, in fact increasing as a proportion of total agriculture, and are not over-compromising resources and the environment as shown in Part 1 (Meissner *et al.*, 2013). However, the industry as a collective and commodity organizations for specific problems need to address major challenges. An important one is competitiveness, which is low because of inefficiency and very little export. By addressing inefficiency the opportunity for export will arise, provided that attitudes change and structures are put in place. Addressing inefficiency is a matter of technology development, technology transfer and mostly communication and dedication. By addressing inefficiency the carbon and water footprint per unit product will be reduced. Commodity organizations, farmer support bodies and research institutions should take the lead in achieving this.

The creation of enabling environments for the livestock industries to operate in the global village is the responsibility of governments. In South Africa this responsibility, although recognized in the DAFF Livestock and Development Strategy (DAFF, 2003), has largely not been implemented because of, other government priorities, a lack of suitably trained officials, vacancies not being filled, lack of support to R & D and extension services, and various other reasons. The lack of initiatives and actions to fast track commercialization of small-scale/developing farmers and alleviate the poverty problem in rural areas is a major concern. Calculations and case studies show that people can be freed from poverty if rural areas can be commercialized, and in the wider context resource influx and export can be realized. Because these farmers are primarily livestock owners, the initiative to relieve poverty must be livestock based.

To be more effective, government (local, provincial, national), agricultural industries as a collective and commodity organizations will have to share the responsibility to enable the services required to effect a viable enabling environment. Government and the livestock industries will have to show a clear and strong commitment. In addition, it may require a paradigm shift by agricultural industries, because it may require working together which they are not used to. Such services, including border and fence control, laboratory and testing services, improvement schemes, R & D, technology transfer and training, must be fully integrated. Also, commodity organizations must take a larger responsibility in assisting small-scale/developing and new farmers to becoming fully-fledged commercial farmers. Only then will livestock agriculture fulfil its potential in job creation, poverty alleviation, food security, rural stability and become a healthy and sustainable industry in South Africa.

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