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Sustainable food procurement in British and Irish zoos

Jonathan Hanson and Diane Holt

Abstract

Purpose. This study assessed the sustainable food procurement of members of the British and Irish Association of Zoos and Aquariums (BIAZA). It also considered the inconsistencies between their animal and human food supply chains, as well as between between their procurement priorities and practices.

Design. A quantitative, cross-sectional approach was employed, involving the use of a web-based questionnaire to gather data from 41 BIAZA members across 21 indicators of food sustainability. The results were considered within a Sustainable Supply Chain Management (SSCM) framework.

Findings. There was considerable variation amongst the issues considered by zoos during the SFP process for their animal and human food operations. For both, local expenditure, nutritional content and packaging reduction were some of the highest scoring indicators in practice and as priorities. The overall levels of SFP were found to be equal between the human and animal food supply chains. Significantly low levels of inconsistency were found between the two, practically and in terms of procurement aspirations. Within both supply chains, there was also very few significant gaps between procurement priorities and actions.

Originality. The originality of this study lies in its comparison of procurement practices and priorities for two contemporaneous but distinct food supply chains. It demonstrates that it is possible to have a high overall degree of consistency between two parallel, but contrasting, supply chains, as well as between procurement priorities and priorities. It will be of use in sustainable supply chain management, particularly within values-led organisations.

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1. Introduction

Food procurement matters for sustainability. The scale of food production's socio-ecological impacts across the world necessitates an urgent engagement with sustainability issues in food supply chains (Maloni and Brown, 2006). This complements a growing body of research on sustainable supply chain management (SSCM) in a range of private (e.g. Srivastava, 2007; Sarkis *et al.*, 2011) and public sectors (e.g. Preuss, 2009; Walker and Brammer, 2012). The procurement phase in particular has the potential to strongly influence the sustainability of sourced products, as well as suppliers' practices (Thomson and Jackson, 2007; Goebel *et al.*, 2012). However, there is less scholarship available on procurement and supply chains within values-based sectors, such as zoological collections (Pullman and Dillard, 2010).

Zoos and aquariums (hereafter referred to collectively as zoos) have increasingly incorporated their conservation efforts into a broader focus on sustainability. In fact, the seminal World Zoo and Aquarium Conservation Strategy argued that zoos have a greater responsibility than most other institutions to tackle such matters, stating that *'biodiversity conservation without action for sustainability is incomplete'* (WAZA, 2005, p. 57). In spite of the links between biodiversity loss and food production, only limited attention has so far been paid to the sustainability of zoos' human and animal food supply chains, and on any inconsistencies that may exist within and between them (e.g. Koldewey *et al.*, 2009; WAZA, 2009).

This study will therefore examine the sustainability issues considered by zoos during food procurement from a SSCM perspective, based on data from 41 members of the British and Irish Association of Zoos and Aquaria (BIAZA). It will also examine the consistency of this sustainable food procurement (SFP) between human (front-of-house) and animal (back-of-house) food supply chains, and between procurement priorities and practices. For the purposes of this research, SFP will be defined as: *The purchasing of food which, throughout every stage of the supply chain, minimises harm to, and promotes the flourishing of, economies, societies and ecosystems, both now and in the future*.

The structure of the paper is as follows. An overview of the relevant literature, namely sustainable food supply chains, generally and in zoos, provides the context for the study. Following an outline of the methodology, the results are presented. Finally, these are discussed and conclusions are drawn.

2. Sustainable food supply chains

2.1 Sustainable supply chains

The traditional supply chain involves the integration of manufacturing processes, from product design and the extraction of raw materials, through to product distribution and customer feedback (Sigala, 2008). Sustainable supply chain management (SSCM) differs from the conventional sort in that it seeks to consider the longer-term, environmental and social impacts of products and processes on a range of stakeholders, not just short-term, economic impacts on shareholders (Carter and Rogers, 2008; Seuring *et al.*, 2008).

Procurement is a key part of SSCM. Implementing sustainable policies at the procurement stage allows an organisation to influence the characteristics of the products and services it will be supplied with (Thomson and Jackson, 2007; Preuss, 2009; Goebel *et al.*, 2012). Walker and Brammer (2012, p. 257) have even defined sustainable procurement as *'the pursuit of sustainable development objectives through the purchasing and supply process'*.

The active consideration of various sustainability issues during procurement will usually be constrained by limited resources, requiring prioritisation to reflect organisational ethos and strategy, so called 'trade-offs' (De Wit *et al.*, 1995; McGlone, 2001). Yet a 'values/action' gap may occur between these espoused values and the actions of organisations or individuals, often related to

issues of financial cost (Kollmuss and Agyeman, 2002; Vermeir and Verbeke, 2006; Carrigan *et al.*, 2011).

2.2 Sustainable food supply chains

Recent decades have witnessed the increasing industrialisation and globalisation of food supply chains (Oosterveer, 2007). Greater quantities of food are now produced at lower financial costs and transported over greater distances. However, these developments have not been without increased socio-ecological impacts, such as biodiversity loss (Balmford *et al.*, 2012). In addition, the significant contribution of the agri-food sector to greenhouse gas (GHG) emissions has been recognised as a particular cause for concern, with the figure for the UK food system estimated to be approximately 19% of the country's total (Garnett, 2008).

Category	*Subcategory*	**Source(s)**
Agriculture	*Sustainable farming*	McGlone, 2001; Wade, 2001; Rimmington *et al.*, 2006
	Local and seasonal produce	Pretty, 2003; Rimmington *et al.*, 2006; Oosterveer, 2007
Animal welfare	McGlone, 2001; Wade, 2001; Busch, 2003; Maloni and Brown, 2006; Rimmington *et al.*, 2006; Sustain, 2007.	
Biotechnology	McGlone, 2001; Wade, 2001; Maloni and Brown, 2006	
Community	McGlone, 2001; Maloni and Brown, 2006	
Environment	*Biodiversity conservation*	McGlone, 2001; Wade, 2001; Busch, 2003; Carter and Jennings, 2004; Rimmington *et al.*, 2006
	Pollution and waste disposal	McGlone, 2001; Wade, 2001; Busch, 2003; Rimmington *et al.*, 2006
Dietary issues	*Limiting foods of animal origin*	Helms, 2004; Garnett, 2008
	Reducing bottled water usage	Sustain, 2007
Fair trade	Wade, 2001; Maloni and Brown, 2006; Rimmington *et al.*, 2006	
Governance	*Consumer information*	Busch, 2003; Rimmington *et al.*, 2006
	Food security	De Wit *et al.*, 1995; Aiking and De Boer, 2004
	International politics	McGlone, 2001; Wade, 2001; Aiking and De Boer, 2004
Health and safety	*Health*	Wade, 2001; Maloni and Brown, 2006; Rimmington *et al.*, 2006.
	Safety	McGlone, 2001; Busch, 2003; Aiking and De Boer, 2004; Carter and Jennings, 2004; Rimmington *et al.*, 2006
Labour and human rights	McGlone, 2001; Busch, 2003; Carter and Jennings, 2004; Maloni and Brown, 2006Rimmington *et al.*, 2006.	
Supply chain management	*Distribution*	Wade, 2001
	Management practices and principles	Wade, 2001
	Procurement	Maloni and Brown, 2006

Table 1 Sustainable food supply procurement issues

In response to these impacts, Morgan (2008, p. 1242) argued that a sustainable food supply chain is one characterised by *'the internalisation of...costs that are externalised in conventional food chains'*. Table 1 outlines many of the issues that SSCM for agri-food could consider. As discussed for

SSCM in general, food procurement also has the potential to influence the rest of the food system by encouraging engagement with these principles (Maloni and Brown, 2006).

2.3 Sustainable food supply chains in zoos

There is a small but growing literature base on sustainability in zoos, although much is not peer-reviewed. The influential World Zoo and Aquarium Conservation Strategy suggested that by becoming more sustainable in their operations, zoos would *'add impetus to biodiversity conservation'* by helping to sustain the natural resource base (WAZA, 2005, p. 55). The UK-oriented Zoos Forum concurred on this point, arguing that the education, conservation and research objectives of zoos should predispose them to act sustainably (Defra, 2006). Furthermore, it has been suggested that, given their focus on biodiversity conservation, zoos have a greater responsibility that many other organisations to adopt sustainable practices (WAZA, 2005; WAZA, 2009). Apart from WAZA (2009), however – with its discussion of sustainable seafood – these documents do not generally stress the link between biodiversity loss and the agri-food sector.

The link between the ethos of zoos and their operations has also been identified as an important area for consideration (Rabb and Saunders, 2005). Townsend (2009) profiled the sustainability practices of 52 BIAZA members but did not compare them with sustainability priorities. BIAZA (2007) and Townsend (2009) also suggested that inconsistencies existed across zoos' front- and back-of-house supply chains with regard to sustainable procurement, but did not test these assumptions.

The idea of sustainable food in zoos has received relatively little attention to date. Table 2 outlines issues relevant to zoos which this study considered. Zoos occupy a unique position as providers of numerous food types for different consumer groups (Hosey *et al.*, 2009). They function as caterers and retailers of food for humans, especially visitors and staff and these aspects of zoo food are often contracted to external operators. They also act as consumers of food via their animal collections, representing thousands of different species overall. With these contrasting roles they therefore tend to have largely separate supply chains for their front-of-house human food and their back-of-house animal food.

Work on seafood by the Zoological Society of London (ZSL) (Koldewey *et al.*, 2009) has been the only comprehensive work to examine the usage of a food type across all dimensions of an institution's operations, although some research on palm oil has been conducted by ZSL (McNamara, 2012). Townsend (2009) briefly mentioned some sustainable food issues, such as seafood and animal welfare, within the wider context of zoo sustainability but did not discuss the issues in detail.

Low and Davenport (2009) found that zoo catering facilities generally exhibited a higher level of sustainable procurement than zoo retail outlets, perhaps because of greater choice editing. Chester Zoo's Café Tsavo, for example, implemented SFP practices and noted reductions in food miles and food waste, as well as a greater incidence of locally supplied and fairly traded products (Davies, 2007). Implementing sustainable procurement, including for food, has also been discussed for zoo shops (Swannie Sigsgaard, 2009).

In addition, there has been a limited focus on the sustainability of animal foodstuffs in zoos, although an article by Schram (2008) did discuss the matter briefly, and Wensing and Gomes (2011) have considered the situation for soya in some Dutch zoos. So far, no mention has been made in the literature of certification for zoo food outlets or supply chains, such as the Food for Life Catering Mark (Soil Association, 2010) and the Green Accord programme for supply chains (Green Accord, 2010).

Category	Indicator number	Sub-category	Sources(s)
Economic	1.1	Sustainability policy	WAZA, 2005; DEFRA, 2006; BIAZA, 2007; WAZA, 2009; Townsend, 2009; Turner, 2009; BIAZA, 2013
	1.2	Consideration of entire supply chain/life cycle	DEFRA, 2006; BIAZA, 2007; Townsend, 2009; BIAZA, 2013
	1.3	Local expenditure	Regan, 2004; Hill, 2008; Schram, 2008; Frediani, 2009; Swannie Sigsgaard, 2009; Townsend, 2009
	1.4	Seasonality	Hill, 2008; Schram, 2008
	1.5	Supplier engagement	Van Wees, 1999; Dierenfeld, 2005; Hill, 2008; BIAZA, 2013
	1.6	Alternative suppliers	Hill, 2008
	1.7	Small suppliers <10 employees	Not mentioned in zoo literature reviewed
Environ-mental	2.1	Animal welfare	Schram 2008; Hosey *et al.*, 2009; Townsend, 2009.
	2.2	Sustainable seafood	Hill 2008; Schram 2008. Koldewey *et al.*, 2009; WAZA, 2009; BIAZA, 2013
	2.3	Sustainable palm oil	Schram, 2008; Wensing and Gomes, 2011; BIAZA, 2013
	2.4	Sustainable farming methods	Schram, 2008; Townsend, 2009; Wensing and Gomes, 2011; BIAZA, 2013
	2.5	GM food	Schram, 2008
	2.6	Packaging reduction	Schram, 2008; Townsend, 2009
	2.7a	Bottled water reduction (human food only)	Not mentioned in zoo literature reviewed
	2.7b	Browse/vegetation grown on-site (animal food only)	Dierenfeld, 2005; Frediani, 2009; Hosey *et al.,* 2009; Townsend, 2009; Veasey, 2010
Social	3.1	Fair trade	Schram, 2008; Swannie Sigsgaard, 2009; Townsend, 2009; BIAZA, 2013
	3.2	Traceability (safe food)	Dierenfeld, 2005; Hill, 2008
	3.3	Cultural produce/traditional varieties	Swannie Sigsgaard, 2009
	3.4	Ethical employment/human rights	BIAZA, 2007; Townsend, 2009; BIAZA, 2013
	3.5	Food provenance as a communication tool	Frediani, 2010; Schram, 2008; WAZA, 2009; BIAZA, 2013
	3.6	Nutritional content (healthy food)	Dierenfeld, 2005; Hill, 2008
	3.7a	Diets rich in animal protein (human food only)	Townsend, 2009
	3.7b	Food security in poorer nations (animal food only)	Not mentioned in zoo literature reviewed

Table 2 Relevant factors for sustainable food procurement in zoos

3. Methodology

3.1 Focus

Based on a critical review of review of the literature, a conceptual framework for SFP in zoos was formulated (see Figure 1). The study tests a number of assumptions about the inconsistencies between and within zoos' food supply chains. Three research questions were identified:

- R1: What are zoos' SFP practices and priorities for their animal and human food supply chains?
- R2: What is the degree of inconsistency between zoos' animal and human food supply chains, in terms of SFP practices and priorities?
- R3: What is the degree of inconsistency between zoos' SFP practices and priorities, for both their animal and human food supply chains?

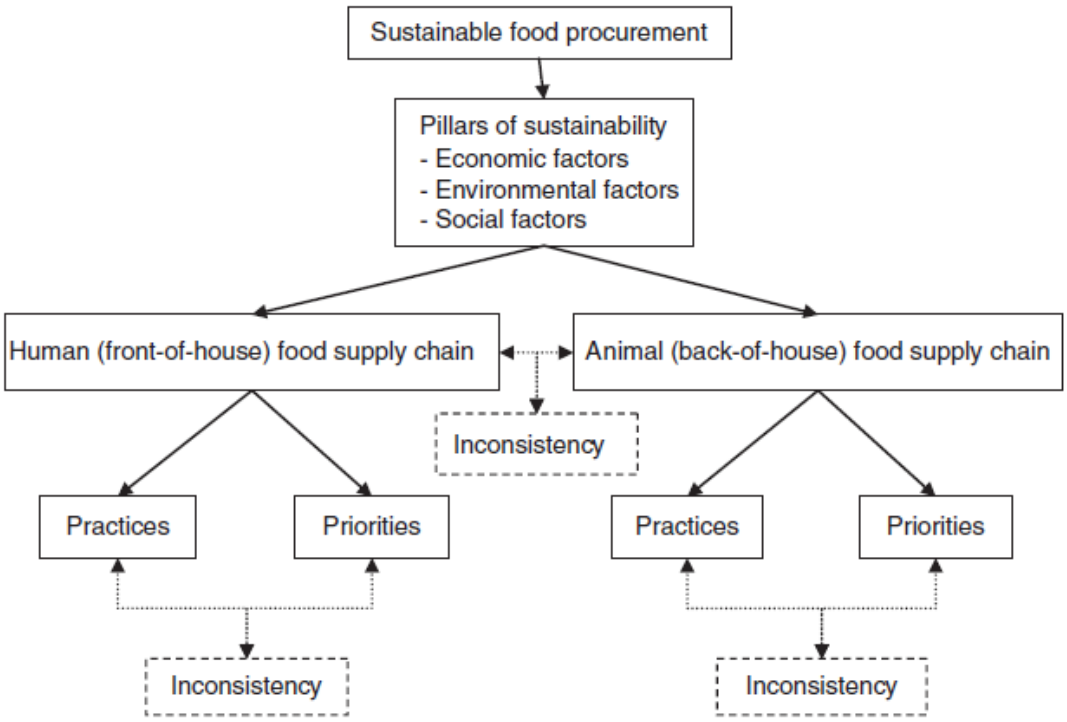

Figure 1 Conceptual framework of sustainable food procurement in zoos

3.2 Sample

BIAZA was chosen as the study sample as it is the national association for zoos and aquariums in the UK and Ireland. It has a central office and research committee through which permission and ethical approval was obtained for the research study. BIAZA members were also the subject of Townsend's (2009) study on sustainability in the British zoological collections sector, and as this study sought to replicate and extend much of her approach, maintaining the same sample population was important. A web-based survey tool was used to collect data from the sample.

3.3 Data collection

Based on a review of the literature detailed in Tables 1 and 2, a series of indicators were developed to allow measurement of SFP. Seven questions each for economic, environmental and social categories were constructed, giving a total of twenty-one indicators – a figure similar to Townsend (2009). Respondents were asked whether they considered each issue in practice when procuring

food for either their animal or human food chains. Following Townsend's (2009) approach, a five point scale was used to record responses, with 'yes', 'sometimes', 'no', 'don't know' and 'not applicable' options. Similarly, and for the sake of simplicity for respondents, the questions were not weighted; each indicator was given equal value.

For the social and environmental sections of the survey, one question in each was divided into two parts, the first being relevant only to human food and the second only to animal food (indicators 2.7a and b and 3.7a and b). Respondents were also asked to rank the same 21 indicators as SFP priorities, with one being the most important and seven being the least for economic, environmental and social sustainability factors respectively.

A pilot version of the survey was then sent to thirteen zoos, with feedback used to refine the survey design. The final version of the survey was also split into two separate versions, for animal and human food, to allow ease of completion by the relevant zoo staff. Respondents were then given one month to fill in the the questionnaire, links to which were emailed to all 95 BIAZA members, along with a document containing the research questions and objectives. All respondents were contacted by email and by phone to encourage their participation. The deadline was also extended by a week to allow for more responses to be collected.

3.4 Data analysis

For the part of the survey which assessed SFP practices, the results were transformed from ordinal variables into numerical variables. This was done by giving a numerical value to each of the response categories: 'yes' = 1.00; 'sometimes' = 0.50; and 'no' and 'don't know' = 0.00. Responses categorised as 'not applicable' were not scored and were discounted from further computation.

The data was then aggregated by calculating the mean for each variable and the process was carried out for both human and animal food chains. Furthermore, for each of the twenty-one indicators, their rankings as SFP priorities were calculated by adding the total scores for each. Due to the scoring system outlined previously, the lowest scoring indicators were the highest priorities, and these were then ranked alongside the same indicators' ranking as practical considerations.

Inferential analysis of the data took two forms. To compare the inconsistencies between human and animal food chains, the numerical results from each indicator in both food chains, except 2.7a and b and 3.7a and b, were combined into single variables. This was done for both procurement practices and procurement priorities. Independent t and Mann-Whitney tests were used to compare the means of the independent groups for variables with ≥30 and <30 cases respectively. The results that were significantly different gave the proportion and percentage of indicators that were inconsistent across both supply chains.

To assess the inconsistencies between procurement practices and priorities, the numerical results from each indicator as practical considerations were tested for correlation with its ranking as a priority. This was carried out for both animal and human food supply chains. Pearson correlation and Spearman rank correlation tests were used for variables with ≥30 and <30 cases respectively. Due to the inverse relationship between priority and score, statistically significant results showed positive relationships, i.e. where a higher score in practice was correlated with a lower priority score.. This gave the proportion and percentage of indicators that were inconsistent between procurement practice and priority. .

4. Results

Three respondents were not able to complete the online survey because of software problems, and another three collections stated that the survey was not relevant to them. Therefore, out of a total of 89 possible responses, 41 were received. This gave a response rate of 46%. The total number of respondents was therefore similar to the 52 received by Townsend (2009). Twenty-five institutions completed both parts of the survey and the number of respondents answering each question varied

between 19 and 35. The response rate was also affected by the timing of the study as it took place during the peak holiday season.

4.1 Sustainable food procurement

The food issues considered by zoos as part of their SSCM varied widely. Table 3 outlines the SFP practices and priorities for their animal and human food supply chains. Local expenditure was the highest scoring practical consideration for human food (0.73), followed by traceability and Fairtrade (both 0.67), and then nutritional content and packaging reduction (both 0.65).

Indicator number	Sustainable food procurement indicator	Food operations							
		Human				Animal			
	Economic sustainability	N =	Practice score	N =	Priority score	N =	Practice score	N =	Priority score
1.1	Use of sustainability policy	31	0.37	20	4.85	35	0.40	29	4.90
1.2	All supply chain stages (life cycle)	32	0.52	21	3.10	35	0.53	30	4.83
1.3	Local expenditure	32	0.73	22	2.59	35	0.80	31	1.84
1.4	Seasonality	31	0.50	22	4.27	34	0.66	31	3.65
1.5	Engagement with suppliers	32	0.38	20	4.30	35	0.50	30	4.53
1.6	Availability of alternative suppliers	32	0.55	21	4.14	35	0.50	31	3.81
1.7	Small suppliers <10 employees	32	0.53	20	4.15	35	0.56	30	4.20
	Mean economic sustainability		**0.51**				**0.56**		
	Environmental sustainability								
2.1	Animal welfare	32	0.59	21	2.24	34	0.44	33	1.55
2.2	Sustainable seafood	32	0.61	21	3.29	35	0.40	33	3.82
2.3	Sustainable palm oil	32	0.38	22	4.14	25	0.30	30	5.07
2.4	Sustainable agriculture	32	0.42	21	3.86	29	0.24	31	3.58
2.5	GM food	31	0.35	22	4.36	31	0.32	30	5.53
2.6	Packaging reduction	31	0.65	22	3.50	34	0.74	32	3.66
2.7a	Reducing bottled water usage	32	0.39	21	5.76	---	---	---	---
2.7b	Browse/vegetation grown on-site	---	---	---	---	35	0.77	31	4.45
	Mean environmental sustainability		**0.48**				**0.46**		
	Social sustainability								
3.1	Fair trade	30	0.67	21	2.57	35	0.29	26	4.00
3.2	Traceability (safe food)	30	0.67	22	3.09	35	0.60	28	2.43

3.3	Cultural produce/traditional varieties	28	0.34	20	4.75	35	0.27	25	4.88
3.4	Ethical employment/human rights	30	0.35	20	4.75	35	0.34	25	4.04
3.5	Food provenance as a communication tool	30	0.45	19	3.53	35	0.43	26	4.50
3.6	Nutritional content (healthy food)	30	0.65	21	3.14	35	1.00	30	1.40
3.7a	Reducing animal protein levels in diets	30	0.23	19	5.63	---	---	---	---
3.7b	Livestock feed and food security	---	---	---	---	35	0.15	24	6.00
	Mean social sustainability		**0.48**				**0.44**		
	Total sustainability		**0.48**				**0.48**		

Table 3 Sustainable food procurement practices and priorities. Scores for practices: 1.00 = highest scoring factor in practice; 0.00 = lowest scoring factor in practice. Inverted scores for priorities: 1.00 = highest priority; 7.00 = lowest priority.

The highest scoring indicator for animal food, and overall, was nutritional content, achieving a complete score of 1.0. Local expenditure (0.80), browse/animal feed being grown on-site (0.77) and packaging reduction (0.74) were next.

Overall, animal food achieved the highest score for economic sustainability, whereas human food scored highest for environmental and social issues. In total, the sustainability scores from both food supply chains were the same at 0.48.

Animal welfare was the highest priority for the human food supply chain, with a score of 2.24. This was followed by Fairtrade (2.57) and local expenditure (2.59). For animal food, and overall, the highest priority was nutritional content (1.40), while animal welfare was second with a score of 1.55 and local expenditure was third, with 1.84.

4.2 Inconsistency between supply chains

There was a relatively low level of inconsistency between animal and human food in zoos. For procurement practices, Table 4 illustrates that only two issues (Fairtrade food and nutritional content) had significantly differing means across the two food supply chains. For procurement priorities, there were more gaps. Life cycle considerations, animal welfare, GM food, Fairtrade food and nutritional content all had significantly different means. Overall, as Table 4 also indicates, there was 10.53% inconsistency between food procurement practices in animal and human food chains, and 26.32% inconsistency between food procurement priorities.

4.3 Inconsistency between procurement practices and priorities

Table 4 illustrates that only one indicator in the human food supply chain responses produced a significant negative correlation between practice and priority, that of 'availability of alternative suppliers'. Similarly, for the animal food supply chain, only the issue of browse (or vegetation) grown on-site produced a significant negative correlation. Table 4 also indicates that one indicator for human food and five other indicators for animal food had negative correlations between practices and priorities. These relationships, however, were not statistically significant. Overall, the significant inconsistency between procurement practices and priorities was 4.76% for both human and animal food.

Indicator no.	Significance level = 0.05 **Sustainable food procurement indicators**	**Consistency between animal and human food supply chains (underlined if significantly different)**				**Consistency between procurement practices and priorities (underlined if significant negative relationship)**			
		Practices		**Priorities**		**Human food**		**Animal food**	
	Economic sustainability	**Test value**	**P value**	**Test value**	**P value**	**Test value**	**P value**	**Test value**	**P value**
1.1	Use of sustainability policy	t=1.017	0.313	U=285.00	0.917	p= -0.510	0.026	p= -0.640	0.000
1.2	All supply chain stages (life cycle)	t= -0.285	0.775	**U=123.50**	**0.00**	p= -0.118	0.610	r= 0.171	0.366
1.3	Local expenditure	t= -0.706	0.483	U=414.50	0.153	p= -0.204	0.362	r= -0.572	0.001
1.4	Seasonal food	t= -1.580	0.119	U=405.00	0.239	p= -0.470	0.032	r= -0.213	0.258
1.5	Engagement with suppliers	t= -1.279	0.206	U-289.00	0.825	p= 0.253	0.283	r= 0.048	0.800
1.6	Availability of alternative suppliers	t= 0.486	0.629	U=355.50	0.571	**p= 0.439**	**0.047**	r= 0.244	0.187
1.7	Small suppliers < 10 employees	t= -0.373	0.710	U=300.50	0.992	p= -0.436	0.055	r= -0.592	0.026
	Environmental sustainability								
2.1	Animal welfare	t= -0.373	0.408	**U=244.00**	**0.40**	p= -0.205	0.373	r= -0.153	0.404
2.2	Sustainable seafood	U=602.00	0.65	U=294.00	0.344	p= -0.486	0.025	r= 0.311	0.078
2.3	Sustainable palm oil	U=444.00	0.429	U=238.00	0.083	p= -0.774	0.00	p= -0.78	0.000
2.4	Sustainable agriculture	U=571.50	0.088	U=357.50	0.544	p= -0.318	0.160	p= -0.066	0.745
2.5	GM food	t= -.0.184	0.855	**U=212.00**	**0.026**	p= -0.586	0.005	p= -0.512	0.006
2.6	Packaging reduction	t= -0.879	0.383	U=334.00	0.748	p= -0.333	0.140	r= -0.199	0.284
2.7a	Reducing bottled water usage	---	---	---	---	p= -0.539	0.012	---	---
2.7b	Browse/vegetation grown on-site	---	---	---	---	---	---	**r= 0.398**	**0.026**
	Social sustainability								
3.1	Fair trade food	**U=221.0**	**0.01**	**U=144.50**	**0.05**	p= -0.282	0.215	p= -0.113	0.581
3.2	Traceability (safe food)	t= 0.451	0.654	U=366.50	0.230	p= -0.657	0.001	p= -0.381	0.045
3.3	Cultural/traditional varieties	U=491.50	0.466	U=247.00	0.944	p= -0.228	0.348	p= 0.050	0.812
3.4	Ethical employment/human rights	t= -0.029	0.977	U=327.50	0.070	p= -0.592	0.006	p= -0.461	0.020
3.5	Food provenance communication	t= 0.231	0.818	U=164.00	0.052	p= -0.048	0.847	p= -0.269	0.184
3.6	Nutritional content (healthy food)	**t= -5.460**	**0.000**	**U=92.50**	**0.00**	p= -0.144	0.532	All variables = 1	
3.7a	Reducing animal protein levels	---	---	---	---	p= -0.470	0.042	---	---

3.7b	Livestock feed and food security	---	---	---	---	---	---	p= -0.543	0.006
Statistically significant inconsistency		**2/19**		**5/19**		**1/21**		**1/21**	
Percentage inconsistency (%)		**10.53**		**26.32**		**4.76**		**4.76**	

Table 4 Inconsistency of sustainable food procurement. Inverted correlations for practice-priority relationships due to inverted scores for priorities: negative test value = positive correlation between variables; positive test value = negative correlation between variables. For test values U = Mann-Whitney test; t = independent t-test; p = Spearman rank correlation; r = Pearson correlation.

5. Discussion

5.1 Sustainable food procurement

Local expenditure has been noted as a key issue for zoo procurement by a number of authors (Frediani, 2009; Swannie Sigsgaard, 2009; Townsend, 2009), contributing, for example, to reduced food miles. Likewise, packaging reduction has also been identified as an important aspect of environmental sustainability in zoos (Schram, 2008; Townsend, 2009), reducing the amount of waste and the costs associated with disposing of it. Both of these indicators scored highly, in practice and as priorities, in both food supply chains. Nutritional content also scored highly in each – reflecting its importance for humans (Maloni and Brown 2006) *and* animals (Dierenfeld, 2005) - but with a marked difference in score between the operational areas.

Traceability and Fairtrade foods were two further indicators that achieved high scores in the human food supply chain, with the latter being the top priority for social sustainability. Both issues reflect valid concerns amongst consumers about food safety (Carter and Jennings, 2004) and about food producers in developing countries (Rimmington *et al.,* 2006) respectively. As retailers and caterers of food for people, zoos also reflect these consumer trends (Hill, 2008; Schram, 2008; Swannie Sigsgaard, 2009). As consumers of food for their animal collections zoos need access to a broad and affordable range of different foodstuffs (Hosey *et al.,* 2009). For these reasons, growing browse, or plant material, on-site for animal feed was found to be an important consideration for back-of-house operations in this study. It allows zoos to source an important component of their animals' diets with minimum cost, transportation and processing (Frediani, 2009; Veasey, 2010).

One of the lowest scoring indicators for economic sustainability, and overall, was the use of a sustainability policy to guide food procurement. However, this is at odds with the importance of such a policy as stressed in the broader sustainability and zoo literature (Wade, 2001; WAZA, 2005; Defra, 2006; BIAZA, 2007; WAZA, 2009; BIAZA, 2013). This dichotomy extended to two other key themes for zoos: animal welfare and biodiversity conservation (WAZA, 2005, 2009). Indicators associated with these concerns - such as sustainable seafood, palm oil and agriculture, as well as animal welfare – did not score highly in either food supply chain. This was despite animal welfare being the highest priority for both aspects of operations. Here, financial cost may be the deciding factor in this trade-off, a widely recognised issue in SSCM (Hassini *et al.*, 2012).

The overall results from SFP practices illustrated that economic sustainability was the highest scoring section in both food supply chains, with animal food scoring higher (0.56) than human food (0.51). However, for both environmental and social sustainability human food scored higher: (0.48 versus 0.46 and 0.48 versus 0.44 respectively). These figures reflect the differing roles that zoos perform in their parallel food supply chains: retailers and caterers of human food, and consumers of animal food. Differing stakeholder groups can affect approaches to SSCM (Carter and Rogers 2008). For front-of-house operations, consumer demand is a key factor in shaping procurement practices while economic issues underpin both sets of operations (Swannie Sigsgaard, 2009; Townsend, 2009). These differences may also explain some of the inconsistencies suggested by BIAZA (2007) and Townsend (2009) between these two operational areas.

5.2 Inconsistency between supply chains

Most indicators were considered consistently across both food supply chains in practice and as priorities. Of the seven that were not, however, four concerned two issues – Fairtrade food and nutritional content. The significance of the latter to animal food reflects the central place of nutrition in modern animal collections (Dierenfeld, 2005), while with human food there is an element of consumer choice. The significance of Fairtrade food for the human food supply chains also illustrated the importance of consumer choice here (Swannie Sigsgaard, 2009), despite zoos' animal collections consuming significant quantities of fresh fruit, that could, potentially, be Fairtrade certified.

The other three issues all concerned the gap between procurement priorities. The significantly higher scores for the issues of GM and life cycle analysis in human food may reflect the greater availability of information in this supply chain (Busch, 2003) as well as consumer preferences (Maloni and Brown, 2006; Schram, 2008). For animal welfare, the situation is more puzzling as the indicator was the highest procurement priority for both aspects of operations. Despite a number of exceptions, the low overall degree of inconsistency between front- and back-of-house operations, for both SFP practices (10.53%) and priorities (26.32%), suggests that the gap between the two supply chains suggested by BIAZA (2007) and Townsend (2009) is not as large as suggested.

5.3 Inconsistency between procurement practices and priorities

Few inconsistencies, or value-action gaps, existed between SFP practices and priorities. For human food, the availability of alternative suppliers was significantly different between the two, being second in practice for economic sustainability but fourth as a priority. The limited availability of alternative suppliers has been noted for some types of animal food in zoos, e.g. particular fish species or specialist feed mixes (Hill, 2008), but not for human food. This may reflect the ready supply of other suppliers in this area.

The issue of browse, or vegetation, grown on-site for animal feed was the only significant value-action gap for the animal food supply chain. It ranked first as a practical consideration but fifth as a priority. As discussed above, this may reflect its importance as a sustainable means of sourcing fresh plant material for zoos' animal collections (Frediani, 2009; Veasey, 2010), but also the relative importance given to other priorities that align more closely with zoos' core value instead, such as animal welfare and sustainable seafood and agriculture (Koldewey *et al.,* 2009; Townsend, 2009). In total, the low degree of inconsistency that also exists between SFP practices and priorities for both front- (4.76%) and back-of-house (4.76%) operations suggests that significant values-action gaps, as discussed by Kollmuss and Agyeman (2002) and Vermeir and Verbeke (2006), are largely absent from zoos' food supply chains.

6. Conclusion

There was considerable variation amongst the twenty-one issues considered by zoos during the SFP process for their front- and back-of-house operations. Local expenditure, nutritional content and packaging reduction were some of the highest scoring indicators in practice and as priorities. Based on this analysis, the levels of SFP were found to be equal between the human and animal food supply chains. Significantly low degrees of inconsistency were found between these operational areas, practically and in terms of procurement aspirations. Within both supply chains, there was also very few significant gaps between procurement priorities and actions.

This study expands upon the work of Townsend (2009) by outlining the specific issues considered by zoos during their SSCM for food, complementing her analysis of general sustainability trends in BIAZA members. It allows zoos to understand the trends and patterns in SFP within their sector. Despite some significant exceptions at the level of individual indicators, it also finds that the inconsistency suggested by Townsend and by BIAZA (2007) between zoos' parallel supply chains is

largely absent in terms of food procurement. Similarly, and again with a few significant caveats, the gap between values and actions for food procurement is also largely absent, despite its prevalence elsewhere at the individual and organisational scales (Kollmuss and Agyeman, 2002; Vermeir and Verbeke, 2006).

The differences that do exist across zoos' front- and back-of-house operations may be explained by the differing functions that they perform: for the former as retailers and caterers, and for the latter as consumers. This has inevitable implications for their SSCM and their SFP, particularly when the primary stakeholder groups for these parallel supply chains - visitors and animals - are so different. Nevertheless, for some individual indicators in particular the challenge for zoos is to carefully align their food procurement practices with their broader organisational priorities, namely animal welfare and biodiversity conservation (WAZA, 2005, 2009).

The study also adds to the literature base on SSCM in values-based sectors (e.g. Pullman and Dillard, 2010). It demonstrates that it is possible to have a high overall degree of consistency between two parallel, but contrasting, supply chains, as well as between procurement priorities and priorities. Furthermore, the study points to the significance of economic factors in the SSCM process.

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