Dairy cattle management, health and welfare in smallholder farms: An organic farming perspective

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Abstract

Organic production principles aim at achieving good animal health and welfare of livestock. The objective of the present study was to investigate animal management, health and welfare in smallholder dairy farms in Kenya, Africa, and to be able to give recommendations which can guide organic livestock production practices as specified by the International Federation of Organic Agriculture Movements and the East Africa Organic Product Standard. A longitudinal study of 24 farms was conducted to document and assess management practices and their potential effect on animal health and welfare. Observation and documentation of animal housing design, cleanliness, feeding management and types of feed available to the cows, milking management, disease and pest management was done in the Kiambu and Kajiado Counties of Kenya. An analysis was performed for indicators of health and welfare with husbandry type, aspects of the housing system, farm characteristics, and management routines. The average herd size was 3.15 in Kiambu and 3.91 in Kajiado, with all the cows' zero-grazed. Seventy five percent of the cubicles were small (less than 2.50m^2). Many of the farmers sprayed their animals weekly (47%) to control ticks, while all incidences of diseases were treated by a veterinarian. Most of the cattle housing flooring were made of concrete (87%) with only one farmer regularly using bedding for the cows. Cows were mainly fed fresh Napier grass (60%) in Kiambu while natural grasses (43%) was the main feed used by farmers in Kajiado. This study indicated that four major challenges exist for organic dairy cattle management in Kenya, which need to be addressed in future research and development: 1) the use of robust breeds and the breeding strategies; 2) grazing and access to outdoor areas; 3) feeding in terms of stability and self sufficiency of enough nutritious feed; and 4) the handling of diseases and pests using poisons, chemical medicines, along with the development of viable alternative disease handling strategies.

Keywords: Organic agriculture, dairy production, livestock management, Kenya, Africa.

Introduction

Organic agriculture is a holistic approach to agriculture and food systems, which promotes and enhances agro-ecosystem health, including attention to bio-diversity, biological cycles and soil biological activity (FAO, 1999). The growth of organic agriculture

is attributed to increasing consumer demand for products perceived as tastier, healthier and produced in an environmentally sustainable system (Pimentel et al., 2005; Hughner et al., 2007; Reed, 2010). The concept of organic livestock production can be considered as a system of livestock production that better fulfills animal needs (Lund, 2006; Verhoog et al., 2007), promotes the use of organic and biodegradable inputs for production (Chander et al., 2011) and reduces the use of routine, conventional synthetic chemical veterinary treatments (EAOPS, 2007). In addition, it incorporates humans and animals as part of a larger ecological system (Baars et al., 2004; Verhoog et al., 2004).

Organic livestock farming aims at maintaining good animal health and welfare. In this system, animal health is not only viewed as the absence of disease but also as resilience in terms of the animals' ability to absorb shocks and pressure from the surroundings and to respond so that they do not become diseased. As such, health is a positive characteristic achieved through the application of animal health promotion strategies and practices, rather than the routine use of conventional veterinary medicines (Vaarst & Alroe, 2012). However, the use of veterinary drugs, antibiotics or chemicals are permitted if preventive and alternative practices are unlikely to be effective in curing sickness or healing an injury, and need to be done under the supervision of a veterinarian (EAOPS, 2007). Animal welfare in organic livestock production is multifaceted and many aspects of an animal's life contribute to its welfare. These include good health and productivity, ability to express natural behaviour, absence of pain or stress, presence of positive emotions, and ethical considerations (Duncan, 1996; Fraser & Broom, 1997; Lund, 2006; Haynes, 2008).

Animal health and welfare is influenced by the ways in which livestock production systems are constructed (Vaarst & Alroe, 2012). Kenyan milk production systems are dominated by smallholder farmers. Smallholder dairy farmers, estimated to number about 2 million households, account for more than 80% of the annual total milk production and more than 70% of total marketed milk in Kenya (SDP, 2005; Wambugu et al., 2011). The farms are mainly concentrated in the Kenya highlands (areas with elevation of ≥ 1000m above sea level) where farmers practice integrated crop-dairy production and keep one to five cows which are exotic or crosses of exotic with local breeds and housed in zero-grazing units. (Bebe et al., 2003a; Wambugu et al., 2011; Muriuki, 2011).

The average milk production in smallholder dairy farms is generally low (Owen et al., 2005; Musalia et al., 2007; Lukuyu et al., 2011), and higher productivity is limited by feed scarcity, infectious diseases and parasites, poor animal husbandry practices, and limited access to extension and veterinary services (Ayantunde et al 2005; Njarui et al., 2011; Onono et al, 2013). Despite these challenges smallholder livestock production on mixed crop–livestock farms is expected to remain dominant in Sub-Saharan Africa for the foreseeable future. Rising incomes, urbanization and preferences by the growing middle classes for a diet that includes livestock products is expected to guarantee income for livestock producers for the foreseeable future (Delgado *et al.,* 1999; Jayne *et al.*, 2003). As a result, the intensification of dairy production by keeping exotic breeds and zero-grazing is widely promoted to meet the increasing demands for dairy products and sustain livelihoods from the limited production resources of land, capital and labour (Bebe *et al*., 2008). Intensification is expected to influence the way these systems operate and affect the health and welfare of livestock in these systems.

Africa has had a long association with the organics project including having a presence at the founding of the International Federation of Organic Agriculture Movements (IFOAM) (Paull, 2010) yet Kenya has just 4,894 hectares of certified organic agriculture which contrasts with its neighbour, Uganda, with 231,157 ha of certified organic agriculture (Willer & Lernoud, 2015). There is great potential for growth of organics in Africa (Olowoake, 2014) and that is especially so in Kenya.

Taking into consideration the situation of smallholder dairy farming system in the two counties in Kenya (Kiambu and Kajiado) coupled with a literature review on the condition of these systems from other studies, the objective of the study was to explore and analyze the animal management, health and welfare in smallholder farming systems and assess these issues in relation to the recommendations made by IFOAM and the East Africa Organic Product Standard (EOPS). In addressing these objectives, this study aimed at enriching the discussion around organic dairy production and smallholder crop-dairy systems to assist in the identification of viable options in space and time to which efforts on organic dairy development could be focused.

Materials and methods

Study area

The study was conducted on smallholder dairy farms in Kajiado County (Ngong) and Kiambu County (Dagoretti and Kikuyu), Kenya. The areas are sub-humid and have an annual mean temperature of 10–18° C, a bimodal rainfall pattern higher than 800 mm annually and are ≥1000 m above sea level. Ngong is located 21 kilometres to the South West of Nairobi while Kikuyu and Dagoretti are located 18 and 20 kilometres west of Nairobi respectively. Both regions are characterized by a high number of smallholder dairy farming units due to the availability of a ready market for milk in the city and its environments.

Selection of farms

Twenty four farms were selected (13 farms in Kiambu and 11 farms in Kajiado); the sample size was based on the need to adequately understand the production system, available resources and logistical considerations. The longitudinal study evaluated the management practices, animal health and welfare in the farms.

Data collection

The data was collected by the first author. Farm monitoring sheets for documenting both the baseline information and the repeated observations were made. The baseline information collected at the beginning of the study include: animal housing, cubicle sizes, land size and land allocation to various enterprises. To assess the animal housing design the following parameters were used: presence and adequacy of roofing, presence, type and state of walls, floor type, presence of resting yards, nature and adequacy of feeding and watering areas. All these were assessed by visual observation and direct measurement. Information related to milk production, feeding, occurrence of animal diseases, treatment, breeding, milking practices, animal housing as well as other farm characteristics were observed and documented during the repeated farm visits. Information on milk production and concentrate feeding, disease occurrences and treatments were recorded using a monthly data card that was given to the farmers each month.

Each farm was visited at least four times, with the first visit in August of 2012 and the last visit in April 2013 to cover the two main seasons experienced in these areas. Feeding management data including type and amount of feed as well as frequency of feeding, type and frequency of mineral supplementation and frequency of watering were obtained by asking the farmer or the worker responsible for feeding the animals.

Milking management, disease management and parasite management data were obtained by observations of how the processes were conducted. These included information on: milking procedure, disease control and prevention measures such as the use of acaricides and vaccinations, and routine practices such as de-worming. The hygiene status of the floor was assessed by evaluation of the frequency of slurry removal and by direct observation by the investigator during farm visits.

Data analysis

Descriptive statistics including analyzing for associations were generated from the data using SPSS for Windows version 14.02 (SPSS Inc., ©1989-2005). Further analysis to assess management of dairy cattle, animal health management and welfare issues in smallholder farms was conducted. Stepwise Cluster Analysis was used to describe the farming system from a set of variables including land size, landholding pattern, land use, housing design, hygiene, calf management, nutrition management breeding and animal health management, and milking practices.

Results

Land holding and land use pattern

There was a significant difference in the average total landholding by smallholder farmers in the two counties. In Kajiado County, the average landholding was 8.23 acres while in Kiambu County the average land holding was 0.74 acres. The average land sizes for pasture, cropping, home/compound and animal housing are shown in Table 1. The animal houses were set up in the backyard near the farmers' houses and all the dairy cows were raised within the zero-grazing units.

Table 1: Land holding and use on smallholder farms in Kiambu and Kajiado Counties.

	Kiambu (N=13)		Kajiado (N=11)	
Type of land use	**Mean (ha)**	**SD**	**Mean (ha)**	**SD**
Land for home/compound	0.19	0.05	0.49	0.29
Land for animal house	0.14	0.07	0.18	0.06
Land for cropping	0.36	0.17	3.25	2.47
Land for cut and carry grass	0.30*	0.20	2.20	1.61
Land not cultivated	-	-	2.78**	2.88
Total land holding	0.74	0.28	8.23	6.70

*, ** only two and eight respondents in Kiambu and Kajiado respectively.

Fifteen percent of the dairy farmers in Kiambu County had land allocated for growing pasture within their farms, with an average of 0.3 acres, while in Kajiado County, all of the farmers had land allocated to growing pasture, with an average of 2.20 acres. Thirty

percent of the farmers in Kiambu County grew pasture along the hedges of their farms but this did not constitute a significant land allocation. Seventy three percent of the farmers in Kajiado had land not cultivated or allocated to a specific enterprise, with an average of 2.78 acres. The cows were not grazed in any of the farms and feed was cut and carried to the cattle in all enterprises.

Housing design and hygiene

Table 2 shows the details of the structures used to house the cows. In both counties taken together, 87% of the animal house flooring was made of concrete. In both counties taken together, 75% of the cubicles were small compared to the recommended size of 1.2m by 2.1m in the extension manual for animal housing (MoLD, 2007). One of the 24 farmers used saw dust/ wood shavings as bedding in the cubicles. Thirteen percent of the farms did not have specific cubicles dedicated to milking their cows and used one of the cubicles otherwise used as a resting area for milking. None of the farms had a dedicated calving area or a sick pen.

Table 2: Details of the cow housing system on the farms in Kiambu and Kajiado Counties.

Parameter detail	Kiambu (N=13)		Kajiado (N=11)	
	Number	%	Number	%
i. Cow shed flooring				
○ Concrete	12	92.3	9	81.8
○ Soil	1	7.7	2	18.2
ii. Milking area				
○ Available	11	84.6	10	90.9
○ Not available	2	15.4	1	9.1
iii. Bedding in the cubicles				
○ Saw dust/wood shaving	0	0	1	9.1
○ No bedding	13	100	10	90.9
iv. Cubicle size				
○ Small size	10	76.9	8	72.7
○ Adequate/ large sized cubicles	3	23.1	3	27.3
v. Ratio of number of cow to the number of cubicles in the animal house				
○ 1:1 – 1:1.9 (cows/cubicles)	4	30.8	5	45.5
○ 1:2 -1:2.9 (cows/cubicles)	4	30.8	2	18.2
○ >1:3 (cows/cubicles)	5	38.5	4	36.3

In most cases the animals were soiled with slurry on various areas of their bodies. In all the cows examined, the limbs, the flanks and the udder were soiled. The main cause of soiling on the animal was accumulation of slurry in the cow house. Removal of slurry and cleaning of the cow housing floors was done at least once per day in 77% and 64% of the farms in Kiambu County and Kajiado County respectively. In the other farms, it was done only occasionally, either once every two days or once per week.

Grazing and outdoor access

All the adult dairy cows were housed in zero grazing units during the course of the study. For calves, 21% of the farms grazed them within the compound during the day and they were housed overnight.

Herd structure

There was no significant difference in the average herd size in both Counties (Table 3). The majority of the studied households owned between 1 and 3 cattle. Milking cows constituted the highest number in the herd structure in Kiambu County while in Kajiado County milking cows and calves were equal in number (Table 3). The only breed of dairy cattle kept by the farmers was Holstein-Friesian and no farmer kept a bull in the herd.

Table 3: Herd structure of visited farms at the beginning of the study.

	Kiambu (N=13)		**Kajiado (N=11)**	
Types of cattle/ Herd size	**Average Number ± SD**	**% in herd structure**	**Average Number ± SD**	**% in herd structure**
Milking cows	1.35 ± 0.65	43.9	1.55 ± 0.82	39.5
Dry cows/ Heifers	0.69 ± 0.63	22.4	0.91 ± 0.83	21.0
Calves	1.00 ± 0.58	33.7	1.55 ± 1.04	39.5
Average Herd size	3.15 ± 0.80)	-	3.91 ± 2.07	-

Calf management

Ninety two percent of the farms had calves at least one time during the period of the study. Calves were housed separately and away from adult animals on all the farms. All farmers fed their calves twice daily; this was done soon after milking. The amount of milk fed to the calf varied from farm to farm and with the age of the calves. Other than milk, calves were mainly fed natural grass or Napier grass or dry crop residues. Protein supplementation for calves was only done regularly on 8% of the farms (which were located in Kajiado).

The age of weaning from milk varied between farms with 38% of the farms weaning the calves at between 11 and 12 weeks while 25% of the farms weaned their calves at between 9 and 10 weeks. Of the farms that weaned their calves earlier, 8% continued to feed calves with pellets till the calves were more than 12 weeks old. Eighty three percent of the farms had a calf pen for keeping the calves. 58% of the calf pens were raised floors made of timber slatted floors, while the others had floors on the ground. Bedding for the calf pens were provide in 17% of the farms. The sizes of the pens in all the farms were similar with an approximate size of between 1.8m^2 and 3m^2. All the calves in the farms were dehorned before three months. Anaesthesia was used in all cases during dehorning.

Milk production and milking practices

Milking was done in parlours in 71% of the farms. Concentrates were used by 75% of the farmers in both regions and were only fed during milking. The estimation of commercial concentrates (dairy meal) for feeding milking cows ranged between 2 to 4 kg per day.

All of the cows were milked twice per day, in the morning at 0600 - 0800hrs and in the evening at 1700hrs to 1900hrs. Hand milking was the only method used for milking on all the farms. Only 13% of the farmers washed their hands with a detergent before milking while 6 farmers did not wash their hands before milking (Table 4). Udder and teat washing with water was done before milking by all the farmers in both counties. In 50% of the farms observed fore-milking was not conducted. 71% of the farmers used milking jelly to soften the teat before milking. Milk was stored and transported in aluminium cans on 75% of the farms, while other farmers mainly use plastic jars during milking. 33% of the farms used detergent for dipping the teats of the cows after milking. Hand washing and order of fore-milking were not consistently practised on most of the farms.

Breeds and breeding management

All cows in the study were exotic breeds. Artificial insemination was the only method of breeding used by the farmers. The farmers observed the animals and called the inseminator when a cow was in heat. Artificial insemination services were mainly offered by private individuals who provided advice to farmers on the best bulls. The main criterion for sire selection for most of the farmers was improving milk production.

Table 4: Milking Procedure in Kiambu and Kajiado Counties.

Parameter detail	Kiambu (N=13)		Kajiado (N=11)	
	Number	%	Number	%
i. Hand washing				
○ Wash hand before milking with soap/disinfectant	1	7.7	2	18.2
○ Washing hands with water only	6	46.2	5	45.5
○ No hand washing	5	38.4	1	9.1
○ Inconsistent practice in milking procedure	1	7.7	3	27.2
ii. Order of fore-milking				
○ Fore-milking before cleaning	1	7.7	0	0
○ Cleaning before fore-milking	1	7.7	5	45.4
○ No fore-milking	5	38.5	3	27.3
○ Inconsistent practice in order of milking	6	46.1	3	27.3

Disease and pest management

All the farmers in both study sites used acaricides preventively on their farms. The majority of the farmers used acaricides once every week, 38% and 55% in Kiambu and in Kajiado counties respectively. Table 5 shows the detailed frequency of acaricide use in both counties. Hand spraying was the only method of application used in both regions. 62% of the farm in Kiambu County and 36% in Kajiado County did not practice routine de-worming for calves or other cattle during the period of the study (Table 5).

During the 8 months of the study, one case of East Coast Fever was reported in Kajiado. Four cases of mastitis were reported of which three of the cases were in Kiambu County. In all cases the treatments were conducted by a Veterinary Officer from the respective location at the expense of the farmers.

Table 5: Helminths and tick control practices in the farms.

Parameter detail	Kiambu (N=13)		Kajiado (N=11)	
	Number	%	Number	%
i. Frequency of application/use of acaricides				
○ Weekly	5	38.46	6	54.55
○ Once every 2 weeks	4	30.77	3	18.18
○ Once a month	4	30.77	2	27.27
ii. Frequency of de-worming				
○ Once every 3 months	1	7.69	1	9.09
○ Once every 5-6 months	4	30.77	6	54.55
○ None	8	61.54	4	36.36

Feeding management

Zero-grazing was the method of cattle rearing practiced by all of the farmers. There was a difference in the type of feed given to the animal in the two counties. In Kajiado the farmers mainly fed assorted species of green grasses followed by Napier grass during the wet season. During the dry season between December and February hay was the most common feed for the dairy cattle. Hay which was mainly used in Kajiado during the dry season was purchased from the agro-veterinary shops around the area.

In Kiambu, the most common feed during the wet and dry season was Napier grass. In Kiambu, there were a number of farmers who grew Napier grass for sale to dairy cattle farmers. However, the second most important feed resource during the wet and dry seasons in Kiambu and Kajiado Counties were different species of grasses collected from various sources and hay respectively. In Kiambu, maize stover also contributed a significant amount of the feed at the beginning of the dry season. The maize stovers used for feeding the cows were mainly purchased from other farmers.

Animal feed was mainly sourced on the farms from Kajiado, while in Kiambu the farmers employed a farm worker who collected feed from various sources including road side and hedges. Mineral salt block was available in 5 out of all the 24 farms visited. Water was fed to the cows ad libitum. There was a supply of clean tap water in both regions.

Discussion

Land holding and use

The results show similar landholding patterns and use in smallholder dairy farming systems in Kenya compared to other tropical countries. Most smallholder farmers own less than 5 ha and allocate most of the lands to crop production rather than pasture

production (Lanyasunya *et al*., 2006; Njarui & Mureithi 2006; Waithaka *et al*., 2006; Musalia *et al*., 2007; Lukuyu *et al*., 2011). Decreasing land sizes in densely populated highlands where most of these farming systems are located makes zero-grazing an important strategy through which smallholders intensify their production.

Small land sizes make it difficult for the farmers to produce sufficient feed for the dairy cattle. As a result, the farmers must rely on feed from other external sources which may vary in quality and quantity depending on the seasons and may not necessarily be organic. The challenge of land also makes it difficult for smallholder farmers to design production systems that can meet the basic requirements of animal health and welfare. Changes to incorporate the animal health and welfare needs of the animals based on the organic standards and principles may involve a trade-off between dairy production and other critical aspects like crop production. To establish the merits or demerits of substituting one enterprise for another a critical analysis on the profitability and practicality of the competing enterprises needs to be done. Meeting the animal health and welfare under smallholder systems will require a review of how these production systems are constructed.

Farm structures and hygiene

Dairy cattle in this study were housed all the time. The design of housing in this study was such that most of the floors were made of concrete and lacked bedding, the cubicle sizes were small and the cow to cubicle ratio was low in many farms. Thus the housing structures in most of the farms were not ideally suited for the cows. The farm structures were not only risks to the welfare and health of the cows. The length and width of cubicles impede comfortable lying down and movement of cows yet cows show a strong motivation to lie down (Cooper *et al*., 2007). Without comfortable and easily accessible lying area, cows will have difficulty in lying, entering and rising (Nguhiu-Mwangi *et al*., 2008). As a result, cows may spend more time standing or lying. This increases risk of injuries thus affecting cow health and welfare.

Lack of bedding on concrete floors as observed in the study increases the risk of cows slipping or falling. Cows in such conditions have to alter their gait to lower friction while walking (Phillips & Morris, 2000). This can lead to injury and a disinclination to walk, making the cows less likely to visit the feeding area despite a motivation to do so, possibly reducing feed intake and production. Concrete floors have been associated with an increased occurrence of hoof lesions due to claw horn disruption compared to straw yards (Frankena *et al*., 1992, Somers *et al*., 2003).

The organic standard does not specify the minimum space requirements for dairy cattle or the stocking density. However, farmers are required to provide animals with bedding where it is appropriate, clean the holding areas regularly, provide living conditions that avoid abnormal behaviour, injury and disease according to the natural behaviour of the animals. To be able to fulfil this requirement structural adjustment of the farms will be required. These changes involve re-designing of the cow housing, changes in the flooring systems and changes in the management of the cow environment. These adjustments may be capital intensive and the question many farmers would ask is whether the additional expenses to cater for the health and welfare needs of the cows can be financially justified. One of the major challenges in making these additional investments is

lack of information on the benefits of these investments on the animal's health and welfare and the economic gains to the farmers.

Grazing and outdoor access

In this study, all cows were zero-grazed. This creates a major conflict in relation to the organic principles and recommended practices. The goals of organic principles are that dairy animals should be managed in a way that allows the expression of natural behaviour and according to their natural behavioural needs. This includes letting the animal have sufficient space for free movement according to their natural behaviour (EAOPS, 2007) and to graze because this is a natural way of feeding for ruminants. Access to outdoor areas and freedom of choice that allows an animal to express individual preferences is also considered to constitute the concepts of naturalness (Lund 2006; Waiblinger *et al*., 2004; Verhoog *et al*., 2007). The EAOPS permits the bringing of fodder to the animal if it is a more sustainable way to use land resources than grazing. However, under such conditions regular outdoor runs must be provided.

Providing for the health and welfare needs of the dairy cows in smallholder production systems require that some farmers purchase (or lease) more land while others will need to allocate more land to dairy production. These changes may require additional capital to invest in purchasing more plots of land and additional labour to ensure that grazing areas or areas for outdoor runs are managed effectively to enhance the health and welfare needs of the cows.

However, there are no specific guidelines that can to be used to evaluate compliance on a number of issues that directly affect animal health and welfare based on the East African Organic Product Standards. For example the EAOPS do not give detailed guidelines on what "sufficient space for free movement" is or what "regular outdoor run" means to ensure that animal health and welfare is not compromised. It is suggested that the standards need to provide definite details for farmers to be able to understand and implement. Since there may be little risk of dairy cow losing organic status as a result of lack of sufficient space the farmers may not see the need for implementing these requirements.

Calf management

In organic dairy production natural living for calves involves cow-calf contact and natural milk feeding from a cow (suckling). Suckling also enables the cow to express natural behaviour and ensures natural communication between the cow and the calf (Grondahl *et al*., 2000; Flower & Weary, 2003). Calves in this study were isolated from their mothers within the first two weeks of birth and were either bucket fed or bottle fed until they were weaned. However, this is much better than the way in which calf management is practiced in most European countries where calves are separated from the cows within a few hours after birth (de Passille *et al.,* 2008). This type of calf feeding is the most common practice by smallholder farmers with zero-grazing units (Bebe, 2008; Lukuyu *et al*., 2011).

Organic feeding standards require calves to be fed with maternal milk or organic whole milk from their own species. Feeding of vitamins, trace elements and supplements from natural sources is also permitted. The organic standards do not define specific time period for weaning and only state that: "Animals shall be weaned only after a minimum

time that takes into account the natural behaviour and physical needs of the animal". In cows, natural weaning has been found to occur from 6 months (Webster, 1994) up to 12 months (Reinhardt & Reinhardt, 1981). Various studies have shown that natural weaning provides welfare benefits of health, psychological wellbeing and natural behavioural expression for both the calf and dam (Solano *et al*., 2007; Wagenaar and Langhout, 2006; Wagner *et al*., 2012).

The variation observed in the amount of milk fed to calves across different days shows that there is no specific feeding management strategy in the farms, yet feeding is the key component in the replacement management procedure within farms in the successful raising of healthy calves (Radostitis, 2001). Lukuyu et al. (2011) observed that the most important constraint to optimum feeding in calves were low milk production by dams and the competition for milk for use in the household and for sale.

The other challenge in calf rearing was lack of bedding and dirty calf pens in most of the farms and this affected the welfare of the calves and could be associated with numerous calf diseases such as gastroenteritis and pneumonia. These two diseases accounted for 44% of calf mortality in farms around Nairobi (Gitau *et al*., 2010). The diseases lead to huge economic losses and deprive the farms of replacement stock for their herds.

Feeding management

The quantity and quality of feed is a major contributor to animal good animal health and welfare. To support animal health and welfare, feeding is required to meet the physiological conditions of the animals. The East African Organic Product Standard requires that diets for dairy cows must derive a minimum of 60% of the dry matter intake (DMI) from organic feedstuff daily. Access to fresh fodder through grazing is preferred and preserved fodder may only be used where fresh fodder is not available.

Organic production views animals in the farm as part of the system and thus recommends that at least 60% of the feed shall come from the farm itself or be produced in cooperation with other organic farms. In Kajiado, farmers produced most of the feed on their own and did not use chemical fertilizers in the grasses that were fed to the cows. However, during the dry season farmers relied on hay which was purchased from the local agro-veterinary shops. It was therefore difficult for farmers to determine how the purchased feed was produced. In Kiambu, feed was sourced from outside the farm throughout the year. The main source of feed was purchased fodder from neighbouring farmers who specialized in fodder production and collecting feed from various sources by the farm workers. In Kiambu, maize stover was purchased from farmers who were not organic farmers.

The organics standard provides specifications for farmers who are unable to graze their animals to use preserved feed of known organic status (EAOPS, 2007). A great challenge for such a farmer will be to get such organic feed for their dairy cows. This is due to lack of traceability of the source of feed and the production method. Incorporation of maize stover produced by non-organic farms will also need to stop since production of maize in most parts of the country involves the used of chemical fertilizers and pesticides.

The amount of concentrates fed to the animal varied from one farm to another. Previous studies show that the quantity of concentrates offered to dairy cattle in smallholder farming systems was generally low (Njarui *et al*., 2011). The amount of concentrate fed

depended on the abilities of the farmers to buy the concentrate. Production and feeding of protein-rich crops has been recommended as a method to reduce the necessity of commercial concentrates in smallholder production systems. The greatest challenge to supplementing the protein requirement through this method is the lack of sufficient land to grow the protein rich-crops in smallholder farmers. This means that even if protein rich crops are to be used as a substitute, smallholder farmers would still have to buy the crop from other farmers. There is a need to develop practical solutions to ensure adequate feed for dairy cows in smallholder systems.

Use of poisons and chemical medicine in disease management

The occurrences of disease in the farms involved in this study were relatively low with only one case of East Coast Fever and four cases of mastitis. However, East Coast Fever, anaplasmosis, babesiosis, trypanosomosis and contagious bovine pleuropneumonia are some of the cattle diseases reported to be endemic in smallholder production systems (Muraguri *et al*., 2005; Zilberman *et al*., 2011). The use of pharmaceuticals are discouraged in organic dairy production and may only be used under the supervision of a veterinarian and where it is the best way to reduce suffering, to save life or restore health. A guideline is given on the withholding periods after treating animals with synthetic veterinary drugs or antibiotics.

In this study, the use of acaricides was a routine practice. Routine use of acaricide is common in smallholder farming systems (Maingi & Njoroge, 2010; Wesonga *et al*., 2010). To conform to the requirement of the organic standard, alternatives to chemical methods of controlling ticks should be adopted in smallholder farms, for example, hand picking of ticks (Rubaire-Akiiki *et al*., 2006). The routine use of acaricide against ticks is used as a preventive measure to tick-borne diseases which are a major cause of losses in smallholder farms. Given the important role played by dairy cattle in the livelihood of most of the farmers, loss of an animal is considered too risky unless there are effective alternative tick control methods, or insurance is in place against losses, should they change their practices.

The organics standards do not provide any conditions that may lead to the removal of organic status of an animal based on the use of synthetic drugs for disease treatment or parasite control even under repeated treatments (EAOPS, 2007). Though the flexibility in the organic standards concerning the maintenance of organic status regardless of the number of treatments provides an opportunity for smallholder farmers faced by numerous disease and pest challenges, this may lead to non-compliance and make use of these synthetics the norm rather than an exception. Since maintaining health is an integral part of animal welfare more work needs to be done to develop methods of disease control that are acceptable in organic production.

Breeding management and breeding objectives

Holstein-Friesian was the only breed kept by farmers in this study with artificial insemination being the only method of breeding used in the farms. The smallholder farmers keep exotic breeds as a key aspect of their intensification strategy in order to increase milk production (Murage & Ilatsia, 2011). Holstein-Friesian is considered as a ‘high maintenance’ animal requiring high energy concentrate and regular veterinary treatment. Exotic breeds have higher nutritional demand, low milk, poor adaptability and

low production efficiency in smallholder production systems (Kahi *et al*., 2000; Wakhungu, 2000).

Most cows kept by smallholder farmers are sourced from commercial herds which may have different sets of objectives. The farmers who use artificial insemination (AI) use the same breeding bulls as conventional farms with the aim of increasing milk production. The choice of AI bull to use is usually determined by the farmer or based on advice from the AI service providers. This is unlikely to change in the near future since the dairy sector in Kenya depends on conventional breeding programmes in Kenya, Europe and USA as the main sources of breeding bulls.

Selection of animals should be based on the requirements of the production system or environment because it plays a role in safeguarding animal health and welfare. In organic livestock production, breeding should not only focus on increased milk production but also consider other important traits required to meet the health and welfare needs of the animal in smallholder systems including resistance to diseases, adaptation to the local environment and utilization of available feed resources. Animals that are genetically adapted to specific conditions are more productive and the cost required for production is lower (Simm *et al*., 2004).

Correct breeding and selection of appropriate dairy breeds should be viewed as a preventive health strategy for organic dairy systems (Marley *et al*., 2010). Long term consideration during breeding and selection may help fulfil the requirements of organic production. Recognition of the role of organic production at the policy level will also play an important role in the future development of organic dairy production since most policies instead advocate for intensification of productivity by increasing animal output and productivity (Devendra, 2001; Bebe *et al*., 2002).

Human choices related to animal farming

Human factors strongly determine our behaviour towards animals, animal production and animal welfare (Boivin *et al*., 2003). This is because the decisions in the farms are dependent on the farmers and have major implication on animal health and welfare. These decisions include the number of cows to keep, the size of cubicles to build and animal management in general. This study showed that in most farms there were low animal to cubicle ratio, small sized cubicle, lack of bedding, dirty loafing areas and cubicles in most of the farm. Ensuring good animal welfare depends on the ability of the farmers to recognize discomfort and ailments facing the animals and taking remedial actions on the causes of discomfort or ailments. Improving the animal welfare situation in the farms studied will require the farmers to make critical decisions concerning the stocking rates, management and structural changes.

The principles of fairness link human and animal relation as part of animal welfare. Vaarst & Alroe (2012) outlined the interfaces between naturalness and human care giving and how the two can be viewed to constitute the concept of animal health and welfare in organic animal farming. The interface of human care giving involve taking responsibility for the animals in the farms that they are not suffering and that they do not experience pain, distress, injuries, frustration, disease, hunger, or thirst. Farmers should be interacting gently and with care with animals in daily life and create a framework which allows naturalness and makes it possible to observe the animals sufficiently without

necessarily interfering. In organic livestock production farmers have an obligation to care for the needs of the animals to guarantee their health and welfare.

Conclusion

The management of cows in smallholder farming systems has an effect on their health and welfare status. Managing these systems is dependent on the way in which the components of the system are organized and the availability of resources. Meeting the provisions of organic dairy production will require adjustments within the smallholder farming system and it is our view that this is achievable in some farms. However, the unique characteristics of each farm needs to be considered when assessing and developing strategies to improve animal health and welfare because smallholder farmers are not a homogenous group. Implementation of strategies developed may require additional resources.

Farmers frequently have poor attitudes towards issues related to animal welfare. There is a need to address the perceptions and attitudes of the farmers and how it affects their relation to the cows within the farms. Training farmers in organic principles will not only safeguard the health and welfare of dairy cattle in these farms but it also has the potential to improve the profitability of the dairy enterprises. Future research to integrate organic dairy production with smallholder farms should focus on addressing the challenges of diseases, pests and feed which are major sources of health and welfare concerns in these systems.

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