Stratified cattle production in pastoral areas of Kenya: Existing forms, driving factors and management practices

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Abstract
Seasonal fluctuations in forage availability in African drylands significantly affect the body condition of pastoral livestock. The result is lean animals that, besides falling short of market requirements, often fetch low prices for producers. In Kenya’s pastoral areas, stratified cattle production (SCP) systems in which animals are transferred from arid to semi-arid areas with better production conditions are emerging as an option to improve animal body condition prior to sale. These practices are gaining popularity against a backdrop of scarce information to guide both the development and up-scaling of the systems. Using qualitative data collected through face-to-face interviews, this study describes the existing forms of SCP, their driving factors and management practices for coping with production and market challenges. Results reveal three forms of SCP that involve fattening of Borana cattle, small East African Zebu and their crosses. The forms were practised by ranchers, traders and agro-pastoralists, who exhibit differences with respect to access to grazing resources, herd sizes and fattening periods. Ranchers owned grazing resources and fatten 100-120 cattle for 6-12 months while traders leased grazing resources to fatten 80-100 cattle for 6-8 months. Agro-pastoralists supplemented pastures with crop residues to fatten 20-30 cattle for 3-4 months. The adoption of SCP systems were driven by changes in socio-economic and ecological conditions in the drylands of Kenya including an occurrence of drought and demand in terminal markets. Practitioners challenges included high costs of animal purchase and production, disease outbreaks and high marketing costs. In order to minimize costs associated with these challenges and maximize profits, animals are purchased during the dry season when prices are low, sale agents are used to source animals and bargain for prices, mature animals that requires a shorter fattening period are purchased, flexible grazing lease arrangements are followed and fattening periods are shortened when there is impending drought. This information could guide the development and promotion of SCP in Kenya and other drylands of Africa.

Keywords: drylands, dry seasons, fattening, lean animals, pasture availability

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Introduction
Pastoral livestock production is practised under marginal climatic conditions, with highly variable rainfall, yet contributes significantly to national economies (Davies & Hatfield, 2007). About 10 – 40 percent of the gross agricultural domestic product of various African countries such as Kenya, Algeria, Mali, Niger, Sudan, Ethiopia, Chad, and Somalia come from pastoral livestock production (African Union, 2010). Pastoral livestock production, therefore, remains one of the most sustainable land use options in the African drylands compared to other land uses such as crop farming (Behnke & Kerven, 2013) and ranching (Angassa & Oba, 2007).

Despite the potential of pastoral livestock production in Africa’s drylands, the temporal variability of rainfall that characterized these areas greatly influences the availability of pasture for livestock production (Muir & Alage, 2009). During a dry season, natural pasture is scarce, deficient in nutrient concentrations (Gwelo et al., 2015) and has high fibre content, which limits animal intake (Leng, 1990). Accordingly, animal body condition fluctuates in response to seasonal changes in pasture production and quality. For example, Nyamukanza et al. (2009) observed dry-rainy season body weight fluctuations from 220 to 450 kg, 290 to 420 kg and 280 to 330 kg in oxen, bulls and cows, respectively, in 2005/2006 in the semi-arid areas of South Africa. Leloup et al. (1996) also attributed low annual weight gain of 35-45 kg per head of Zebu cattle in southern Mali to seasonal fluctuations in pasture availability and quality. Seasonal dynamics in pasture availability and
quality in Africa’s rangelands also influence animal reproductive performance (Kanuya et al., 2006), capacity to provide draught services (Bartholomew et al., 1993) and animal market value (Barrett et al., 2003).

Stratified livestock production in which livestock are transferred from arid regions where rainfall is low and highly variable to semi-arid areas with better production conditions, is an emerging option for improving the body condition of lean pastoral livestock to meet market requirements. More often than not, stratified livestock production enhances body condition of animals, which is expected to translate into increased prices, and by extension, increased income for producers and traders. For example, Ankole cattle and their crosses of Borana and Friesian expressed a daily weight gain from 0.27 kg/day to 0.55 kg/day when supplemented with concentrates in the semi-arid region of Uganda, in a traditional grazing system (Asizua et al., 2009). Local cattle breeds bought from farmers and put in feedlots in South Africa had better carcass quality and met terminal market specifications (Strydom et al., 2008). In Nigeria, supplementation of White Fulani steers with crop residues during a dry season helped in maintaining the animals’ body weight attained during the previous rainy season (Areheore, 2009). In addition, Little et al. (2014) reported enhanced market value and profit made by traders from fattening of drought-stricken cattle purchased from pastoral areas of southern Ethiopia during the 2010/2011 drought. These authors observed that the traders made a substantial profit despite losing 10 percent of the herd during transit to feedlots. According to Nowers et al. (2013), cattle sourced from communal areas of South Africa increased their growth rate when management practices such as feeding, dipping and vaccination were improved.

In Kenya, stratified cattle production (SCP) was pioneered by the government in early the 1960s to improve the quality of animals brought from the pastoral areas so that they meet the standards demanded in international markets (Raikes, 1981). Livestock holding grounds, stock routes and quarantine areas were established with the support of the Livestock Marketing Division (African Union Inter-African Bureau for Animal Resources and North Eastern Pastoral Development Program, 2006). Cattle from arid northern Kenya were bought and fattened in ranches and slaughtered at the Kenya Meat Commission (KMC) for export and domestic markets. Under this arrangement, beef prices were controlled by the government especially in urban markets (Raikes, 1981). After the liberation of the beef market in 1986/87, there was an insufficient supply of cattle for slaughter at the KMC, which led to the collapse of the government-supported beef marketing operations (van der Valk, 2008). However, since the 1999/2000 drought in Kenya, SCP has increasingly been adopted in its original or modified forms (Mahmoud, 2006; Farmer & Mbwika, 2006). This practice is gaining popularity against a backdrop of scarce information to guide both the development and up-scaling of the system. The objectives of this study were, therefore, to identify and characterize the existing forms of SCP, and document factors underpinning their adoption, challenges experienced by practitioners and coping mechanisms they have developed. This information is important for guiding the marketing of lean cattle through stratified production systems, especially during the dry season when pasture availability in pastoral areas is limited.

Materials and Methods

The study was conducted in Taita Taveta, Laikipia and Narok Counties located in the semi-arid areas of Kenya (Figure 1). The counties were selected based on information from literature reviews as well as interactions with stakeholders. Contrary to arid areas of Kenya where vegetation is mostly patchy dwarf shrubs and annual grasses (Makishima, 2005), vegetation in the study areas ranged from wooded savannah to open grassland dominated by perennial grasses such as Pennisetum mezianum, Digitaria spp., Themeda triandra, Cenchrus ciliaris, Chloris roxburghiana and Enteropogon spp., among others. Taita Taveta County has an annual rainfall of about 200-587 mm in the lowland areas where livestock production is the dominant livelihood activity (Pellikka et al., 2009), while Laikipia County receives 500-550 mm rainfall on average per year (Okello et al., 2001). The average annual rainfall for Narok County is about 400–500 mm in the savannah plains where livestock production and wildlife conservation are the main economic activities (Serneels et al., 2001). Rainfall, for the three counties, is bi-modally distributed with a short rainy season occurring from March to May, and a long rainy season from November to December. In Taita Taveta, Laikipia and Narok, during the short rainy season, temperatures are 21–29°C, 15–27°C, and 15–25°C, while during the long rainy season they are 20–28°C, 14–24°C, 14–25°C, respectively (data sourced from the NASA Prediction of Worldwide Energy Resource, https://power.larc.nasa.gov/cgi-bin/agro.cgi?na, accessed 2018 April 23). In all the three counties, the short rainy season is slightly warmer than the long rainy season.
Cattle ranching and wildlife-based tourism are among the main economic activities in all the study areas. Taita Taveta County has a number of private and cooperative livestock ranches established by the government in the 1960s and early 1970s with the support of the World Bank to boost national livestock production (Aklilu et al., 2002). Although the initial objective of these ranches was livestock breeding, the ranches are now mainly used for SCP by livestock traders (Mahmoud, 2006). Similarly, Laikipia County has a number of ranches which either practice SCP or lease grazing resources to livestock keepers during periods of drought (Heath, 2001). In Narok County, local livestock traders are also increasingly adopting SCP to maximize revenues (Personal communication with Manager of Ramat Livestock Marketing Group in Suswa, Narok County, 2015).

Figure 1 Map of Kenya showing counties in which the study was conducted (Source: Generated using ArcGIS 10.2, ESRI 2011)

Thirty-four SCP practitioners were identified with the help of local leaders, livestock production, extension, and veterinary officers in the three study areas. Narrative interviews were conducted with the identified practitioners according to the procedure by Jovchelovitch & Bauer (2000), which suggests that the interviewee gives uninterrupted narration following by probing where details were not provided. The purpose of narrative interviews was to identify existing forms of SCP and to provide comprehensive content of each research objective that would guide semi-structured interviews. The narrative interviews provided information on operational and animal husbandry practices from the purchase of animals until sale, the motivation for adopting SCP, the challenges or risks encountered, and management practices for reducing costs associated with these challenges. The data from the narrative interviews were coded for qualitative content-analysis where information relevant to answering the research objectives was sorted and organized into clusters as described by Mayring (2014). A systematic coding process was followed in which codes were defined, followed by revision, final coding and lastly interpretation as shown in Figure 2. This method has the advantage of providing in-depth analysis from respondents’ narration (Hsieh & Shannon, 2005). The data from the narrations helped in identifying three categories of SCP based on the different operational activities and animal
husbandry practices. Semi-structured interviews were then conducted with 73 respondents (including respondents for the narrative interviews) using information generated through narrative interviews as a checklist to establish difference in the factors that drive adoption and in management practices across existing forms of SCP. A chi-square test (SPSS version 20, 2011) was used to test their statistical differences at 5% significance level.

Figure 2 Step-by-step procedure of content analysis (Adopted from Mayring, 2014)

Results

Three forms of SCP that involve fattening of Borana cattle, small East African Zebu and their crosses were identified. The forms differed in terms of access to grazing resources, herd sizes, class of cattle targeted, animal husbandry practices, duration of fattening and livestock market outlets (Table 1). One form of SCP was practised by private ranchers, who owned large tracts of land mainly used for livestock production in Laikipia and Taita Taveta Counties. Ranchers kept two types of cattle herds; ranch raised herds for breeding and purchased herds for fattening. The latter were mainly 3 to 4 year-old steers and bulls bought from pastoral areas for fattening before sale. The ranchers quarantined the purchased cattle at strategic places and vaccinated them against notifiable diseases such as foot-and-mouth disease (FMD), anthrax, lumpy-skin disease (LSD), and contagious bovine pleuropneumonia (CBPP) before allowing them into the ranches. Vaccination against FMD and anthrax was repeated every 6 to 7 months while vaccination against lumpy-skin and CBPP was done once in a year. Animals were watered every day during the rainy season but after every two days in the dry season. Salts of various brands were provided ad libitum either in mixtures (salts of different brands) or separately. The ranchers sprayed the animals against external parasites and dewormed them a few days after purchase, and thereafter the animals were sprayed every week and deworm every three months. No withdrawal period prior to slaughter was suggested either in the use of pesticides or de-wormers but it is unlikely that the animals were de-wormed less than a month before selling or sprayed a few days prior to marketing, as such practices could increase production costs.

The second form of SCP was practised by traders, who leased grazing resources from ranchers. Under this model, a short-term (30 days or less) or a long-term (usually for 12 months or more) lease was agreed. Cost of a short-term lease ranged from $0.98 to $1.47 per head of cattle per month and the fee for a long-term...
lease ranged from $9.84 to $29.54 per 0.4 hectare per year. The traders’ animal husbandry practices were similar to those of the ranchers. The third form of SCP was practised on smallholder farms by agro-pastoralists who kept both breeding and purchased cattle herds in an integrated crop-livestock production system in Laikipia and Narok Counties. These agro-pastoralists grazed their animals on natural pastures and moved them to cultivated parts of the farms to use crop residues from harvested maize, wheat, and beans. There were no disease preventive measures when the animals enter or leave farms, but quarantine was imposed and market access restricted whenever there was a disease outbreak.

**Table 1** Forms of SCP identified in the Taita Taveta, Laikipia and Narok Counties in Kenya

<table>
<thead>
<tr>
<th>Form of SCP</th>
<th>Type of Practitioner</th>
<th>Where practiced (County)</th>
<th>Characteristics</th>
<th>Herd size (Head)</th>
<th>Class of cattle</th>
<th>Animal husbandry practice</th>
<th>Period of fattening (months)</th>
<th>Market</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCP on private ranches</td>
<td>Ranchers (n = 10)</td>
<td>Taita Taveta, Laikipia</td>
<td>Own ranches either as companies or cooperatives</td>
<td>100-120</td>
<td>Steers and bulls</td>
<td>Regular vaccination, daily watering, <em>ad-libitum</em> salt provision, weekly spraying and deworming every three months.</td>
<td>6-12</td>
<td>Abattoirs and slaughterhouses in Nairobi and other major towns.</td>
</tr>
<tr>
<td>SCP on leased ranch pastures</td>
<td>Traders (n = 12)</td>
<td>Taita Taveta, Laikipia</td>
<td>Pastures leased from ranchers</td>
<td>80-100</td>
<td>Steers and bulls</td>
<td>Regular vaccination, daily watering, <em>ad-libitum</em> salt provision, weekly spraying and deworming every three months.</td>
<td>6-8</td>
<td>Abattoirs and slaughterhouses in Nairobi and other major towns. Occasional export to Mauritius.</td>
</tr>
<tr>
<td>SCP on smallholder farms</td>
<td>Agro-pastoralists (n = 12)</td>
<td>Narok, Laikipia</td>
<td>Supplement natural pastures with crop residues</td>
<td>20-30</td>
<td>Steers, bulls, cows, heifers</td>
<td>Occasional vaccination, daily watering, spraying after every two weeks and deworming every four months.</td>
<td>3-4</td>
<td>Local markets.</td>
</tr>
</tbody>
</table>

Source: Individual interviews

A number of factors were cited as reasons for the adoption of SCP in the pastoral areas of Kenya. These include the occurrence of drought, market demand and financial gains associated with the production system (Table 2). These factors did not differ with type of practitioners (P > 0.05). Drought as one of the factors that motivated the adoption of SCP was mentioned by majority of the ranchers, traders and agro-pastoralists. Ranchers indicated that the annihilation of a large proportion of ranch-raised herds by droughts led to the underutilization of the ranch carrying capacities in the post-drought periods, which necessitated adoption of SCP. At the same time there was a rising demand for quality animals in the terminal markets e.g. disease-free animals with high live-weights and fat-content. Demand for ranch leasing arose from the traders’ need to capture financial gains associated with the market demand. However, the proportion of ranchers, traders or agro-pastoralists who cited terminal market demand or financial gain as motivational factors for the adoption of SCP was low. For the agro-pastoralists, SCP also provided an opportunity to cope with limited availability of grazing resources on communal grazing areas by keeping cattle for a shorter period and selling them just before grazing conditions deteriorated.

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Several production and market challenges were mentioned by the respondents, namely: high animal purchase cost, high production cost, disease outbreaks, high marketing cost and fluctuation in livestock market values. The high purchase cost often arose from exorbitant transportation charges during rainy periods when existing roads become less accessible. In addition, animals purchased at the end of a prolonged dry season are usually had poor health, leading to mortalities during transit to fattening areas. Weak animals on transit could not withstand transportation stress or injuries related to loading or unloading activities. High production cost was associated with increased use of production inputs such as feeds, water and drugs, especially where fattening periods were extended. In circumstances where cattle were not vaccinated against FMD, anthrax, LSD, and CBPP, disease outbreaks increased the cost of treatment, delayed off-take and increased mortalities. Delayed payments by the buyers and rejections of the animals by exporters also exacerbated marketing costs. High volatility in livestock selling prices, compromised producers’ selling horizons, especially when the targeted period for selling animals coincided with low cattle prices.

In order to minimize the losses associated with these challenges, various management practices were adopted (Table 3). For example, to reduce purchase cost, animals were either bought towards the end of a dry spell or during drought when cattle prices were relatively low. The majority of ranchers, traders and agro-pastoralists purchased animals during dry season. However, those with insufficient grazing resources, purchased cattle during a rainy season to ensure the availability of adequate pasture and water. Prior arrangements were made with the agents or primary traders to source the correct type and the number of animals and negotiate prices. About half of the ranchers or traders and a quarter of the agro-pastoralists use agents in sourcing animals for SCP. Decision when to truck or trek the animals in order to minimizing transportation costs was carefully considered. Trucking was reported to be cheaper during drought when trucks that transport relief food to pastoral areas are available to transport cattle on return-trips at relatively low costs. Trekking was deemed convenient during rainy seasons when roads are impassable and surface water is available along the stock routes.

A long fattening period, especially when extended into dry seasons or drought conditions was said to take more resources and increase production costs. In response to this challenge, mature animals of approximately three to four years old or more are purchased, as they require short fattening periods. The percentage of the traders or agro-pastoralists that purchase mature animals of 3 to 4 year old was more than that of the ranchers. In addition, practitioners shortened fattening periods when they expected imminent prolonged dry or drought periods to minimize production costs, which are often high during such times. The proportion of traders or agro-pastoralists that shortened animal fattening periods when the prolonged dry season or drought was imminent was higher than that of ranchers (P <0.05). To minimize production costs, a few ranchers also engaged in non-livestock income generating activities such as carbon trading and eco-

**Table 2 Drivers of SCP in Taita Taveta, Laikipia and Narok Counties in Kenya**

<table>
<thead>
<tr>
<th>Driving factors</th>
<th>SCP practitioner</th>
<th>Percentage of SCP practitioner (%)</th>
<th>Degree of freedom</th>
<th>Chi-square</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drought occurrences</td>
<td>Ranchers</td>
<td>61.1</td>
<td>2</td>
<td>1.044</td>
<td>0.593</td>
</tr>
<tr>
<td></td>
<td>Traders</td>
<td>47.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Agro-pastoralists</td>
<td>46.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Terminal market demands</td>
<td>Ranchers</td>
<td>27.8</td>
<td>1</td>
<td>0.579</td>
<td>0.447</td>
</tr>
<tr>
<td></td>
<td>Traders</td>
<td>39.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Financial gains</td>
<td>Ranchers</td>
<td>33.3</td>
<td>2</td>
<td>1.275</td>
<td>0.529</td>
</tr>
<tr>
<td></td>
<td>Traders</td>
<td>39.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Agro-pastoralists</td>
<td>25.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Individual interviews (Ranchers = 18; Traders= 23; Agro-pastoralists = 32)
tourism, and used part of that revenue to support SCP in terms of developing water sources and fire-breaks in the ranches. For traders, production costs were also minimized by sharing the costs of development and maintenance of water sources in leased ranches with landlords and also seeking short-term and flexible lease arrangements. Agro-pastoralists practised integrated crop-livestock production system and used crop residues as supplementary feed at times of pasture scarcity. Ranchers took animal insurance cover, valued at a cost of 3% of the animal’s market value to guard against financial losses related to mortalities. Traders had options of paying premium fees ($4.8–5.0 per cattle per month) to their landlords who may provide specialized animal management (herding, daily watering, weekly spraying, deworming, and vaccination against notifiable diseases). The premium fees were payable after every off-take of animals.

In order to reduce marketing costs, some SCP practitioners requested the buyers to pay the market taxes or reimburse them part of marketing cost. The proportion of the traders or agro-pastoralists that shared marketing cost with buyers was significantly higher than that of the ranchers (P > 0.05). For the traders, marketing costs were reduced by getting back firth quarter (offals, heads and hides) of the animals from the buyers—a deal negotiated based on prices offered for the animals. Selling of fattened animals to markets where stringent sanitary standard requirements were in place was minimized to avoid rejection during a disease screening process. A small percentage of ranchers or traders sought supply agreements with slaughterhouses or supermarkets to cope with fluctuations in animal market values. Animal sales were also planned to coincide with the October to December period when livestock prices in the market are usually better due to high demands that are related to the end of year festivities.

Table 3 Management practices for reducing costs among ranchers, traders and agro-pastoralists involved in SCP in Taita Taveta, Laikipia and Narok Counties in Kenya

<table>
<thead>
<tr>
<th>Management practice</th>
<th>Type of SCP practitioner</th>
<th>Percentage of respondents (%)</th>
<th>Degree of freedom</th>
<th>Chi-square</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchasing animals during dry season when livestock prices are low</td>
<td>Ranchers</td>
<td>66.7</td>
<td>2</td>
<td>0.736</td>
<td>0.692</td>
</tr>
<tr>
<td></td>
<td>Traders</td>
<td>78.3</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Agro-pastoralists</td>
<td>75.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use of agents or primary traders in sourcing animals and bargaining for better prices</td>
<td>Ranchers</td>
<td>55.6</td>
<td>2</td>
<td>4.681</td>
<td>0.095</td>
</tr>
<tr>
<td></td>
<td>Traders</td>
<td>39.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Agro-pastoralists</td>
<td>25.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduce transport cost by understanding when it is cheaper to truck or trek the animals from supply source</td>
<td>Ranchers</td>
<td>33.3</td>
<td>2</td>
<td>2.178</td>
<td>0.337</td>
</tr>
<tr>
<td></td>
<td>Traders</td>
<td>52.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Agro-pastoralists</td>
<td>34.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purchase mature animals (3 – 4 years old) that take shorter fattening period</td>
<td>Ranchers</td>
<td>38.9</td>
<td>2</td>
<td>3.955</td>
<td>0.138</td>
</tr>
<tr>
<td></td>
<td>Traders</td>
<td>65.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Agro-pastoralists</td>
<td>65.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shorten fattening period when there is impending drought</td>
<td>Ranchers</td>
<td>22.2</td>
<td>2</td>
<td>15.378</td>
<td>0.010*</td>
</tr>
<tr>
<td></td>
<td>Traders</td>
<td>65.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Agro-pastoralists</td>
<td>78.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negotiating for short-term and flexible ranch lease arrangements that allow for termination as deemed necessary by the lessee</td>
<td>Ranchers</td>
<td>17.4</td>
<td>1</td>
<td>0.889</td>
<td>0.348</td>
</tr>
<tr>
<td></td>
<td>Traders</td>
<td>21.9</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Agro-pastoralists</td>
<td>30.4</td>
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<td></td>
<td>Ranchers</td>
<td>37.5</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Sharing of marketing costs between sellers of fattened animals and buyers</td>
<td>Ranchers</td>
<td>10.0</td>
<td>2</td>
<td>9.560</td>
<td>0.008*</td>
</tr>
<tr>
<td></td>
<td>Traders</td>
<td>34.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Agro-pastoralists</td>
<td>40.6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Make supply agreement with slaughterhouses or supermarkets to avoid animal price fluctuations</td>
<td>Ranchers</td>
<td>11.1</td>
<td>1</td>
<td>0.078</td>
<td>0.781</td>
</tr>
<tr>
<td></td>
<td>Traders</td>
<td>26.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plan of sale of fattened animals to coincide with the period of high livestock demand</td>
<td>Ranchers</td>
<td>33.3</td>
<td>2</td>
<td>0.268</td>
<td>0.875</td>
</tr>
<tr>
<td></td>
<td>Traders</td>
<td>39.1</td>
<td></td>
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<tr>
<td></td>
<td>Agro-pastoralists</td>
<td>40.6</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Individual interviews (Ranchers n = 18, Traders n = 23, Agro-pastoralists n = 32), *significant at 5% level.
Discussion

Forms of SCP found in this study differed with regard to access to grazing resources, number and classes of animals purchased, animal husbandry practices, fattening periods and market outlets. Ranchers who practised SCP on private ranches, fattened larger herds for longer periods compared to traders and agro-pastoralists who practiced SCP on leased grazing resources and on smallholder farms respectively. The differences in herd size and fattening period were most likely influenced by the availability of and access to grazing resources. Traders and agro-pastoralists had less access to grazing resources, which prevented them from sustaining large herds for long periods, contrary to ranchers. In a study conducted in Mieso Woreda in Ethiopia, Tegegne et al. (2011) reported that when grazing resources for cattle fattening are limited, fattening periods are either shortened or planned to coincide with a period of feed availability. They further observed that agro-pastoralists in the study area undertake cattle fattening during the period of June to November, when there is sufficient feed, and subsequently sell the finished animals before their body conditions deteriorate.

This study found that while ranchers and traders mainly targeted bulls and steers for SCP, agro-pastoralists fattened herds of mixed classes of animals. The agro-pastoralists also own breeding herds, which are herded together with the animals purchased for fattening, particularly if there are few purchased animals or there is no enough labour to herd the animals separately. Agro-pastoralists who herd the purchased animals together with their own breeding herds may choose to purchase cows, heifers, and steers as a way to control breeding, while those who can afford herding labour herd bulls and other classes of cattle separately. Controlled breeding is essential to maintain breeding herds that are adapted to local ecological conditions and able to meet the multiple objectives of livestock keepers (Ayantunde et al., 2007). Animal husbandry practices were different in the identified forms of SCP, principally in terms of vaccination frequencies. Ranchers and traders were found to undertake regular vaccination, while agro-pastoralists only vaccinate occasionally, especially when there is an outbreak of a notifiable disease. As reported by Onono et al. (2013), in a study conducted in Kajiado County of Kenya, agro-pastoralists occasionally vaccinate their herds, despite high incidences of notifiable diseases. The difference in vaccination frequencies may not reflect variation in disease incidences across the study areas, but possibly relate to affordability of or access to vaccines. Homewood et al. (2006) investigated association between uptake of a veterinary intervention and the ability of livestock keepers of Mairowa area in Tanzania to pay for the intervention. They concluded that herd sizes and wealth status play a role in the use of livestock vaccines and that wealthy households tend to vaccinate a larger percentage of their herds than their poorer counterparts do.

Variation in the market outlets among the actors was observed in this study, where ranchers and traders were found to target major abattoirs and slaughterhouses in urban towns, while agro-pastoralists sell the finished animals at local markets. This suggests that cattle sold by the ranchers and traders, as opposed to those offered for sale by agro-pastoralists, meet the characteristics (e.g. animal body weight and fat-content) required in the terminal markets (Aklilu, 2008). On the other hand, the observed difference in the market outlet can also mean that agro-pastoralists do not have access to different terminal markets. According to the synthesis report by the African Union Inter-African Bureau for Animal Resources and North Eastern Pastoral Development Program (2006), choice of livestock market outlets in Kenya depends on market infrastructure including stock routes that connect livestock production areas to terminal markets. In all the identified forms of SCP, fattened animals were sold directly, without feedlot finishing, unlike in other cattle fattening systems in countries like Botswana (Farrington et al., 1989), Ethiopia (Teklebrhan & Urge, 2013) and others. This is despite the potential of feedlots to improve carcass quality of indigenous cattle in Kenya (Creek, 1973) and other areas with a similar ecological system (Asizua et al., 2009). In Kenya, the high costs of feed and infrastructure constrain feedlots establishment and operation (Kahi et al., 2006).

Most ranchers, traders and agro-pastoralists in the current study cited drought as the main driver of adoption of SCP. The SCP, therefore, simply exemplifies one of the adaptation pathways to increasingly unpredictable and adverse climatic conditions such as droughts in the drylands of Kenya. By fattening animals for short periods, when pasture is available, and selling them before the pastures deteriorate, the practitioners were able to cope with pasture scarcity associated with extended dry seasons and periods of drought. The adoption of SCP in response to drought conditions also indicates that livestock producers in African drylands are dynamic and constantly innovate new approaches to cope with challenges. In a study conducted among the Maasai in Tanzania, Goldman & Riosmena (2013) showed how households with large herds coped with droughts by selling some of their cattle and paying for private access to pasture outside their communal grazing lands.

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In southern Ethiopia, Taye & Lemma (2009) reported value addition of supplementary feeds such as crop residues and dry grasses by chopping, soaking in water and sprinkling with salts to enhance cattle fattening. Such innovative approaches are critical, given that drought-induced herd die-off has become more pronounced in recent years with the increase in frequency and severity of drought events (Oba, 2001), and the traditional drought coping mechanisms being constrained mainly by changes in land use (Fratkin, 2001; Lamprey & Reid 2004; Galvin, 2009). Stratified Cattle Production, therefore, offers an option to cope with drought, in addition to other drought coping mechanisms reported by Scholtz et al. (2016), which include the use of environmentally adapted breeding stock, production and storage of quality hay and improved access to water.

A demand for quality animals from terminal markets was reported as another motivational factor for the adoption of SCP. The demands for quality animals could be a result of the growing population and income growth, in developing countries (Delgado, 2003). However, access to terminal markets is dependent on other market conditions including sanitary and phytosanitary standards of livestock products (Hall et al., 2004), as well as pre-slaughter animal welfare and conditions such as hunger and fatigue when animals are transported over long distances to slaughterhouses (Chulayo et al., 2012). The market conditions are hardly met when livestock are directly supplied from remote pastoral areas for slaughter in urban markets. In order to meet terminal market conditions and promote livestock trade, especially export, the Kenyan government has plans to implement disease-free livestock production zones under Kenyan’s Vision 2030 project (Government of Kenya, 2007). The implementation of the project may resolve the challenge of disease outbreaks experienced by practitioners and enhance the adoption of SCP in Kenya.

Despite SCP adoption in the context of socio-economic and ecological changes in the pastoral areas of Kenya, there were challenges of high purchase and production costs, diseases outbreaks and high marketing costs. These challenges were similar to those that have been reported in other studies (Destá et al., 2006; Rufael et al., 2008; Onono et al., 2015) and have also been found to influence livestock production and marketing in the pastoral areas of eastern Africa. However, the SCP practitioners were found to have management strategies to cope with the challenges and to maximize profits. Most of the management practices for cost reduction did not differ with the form of SCP, suggesting that the practices were equally important to the ranchers, traders as well as agro-pastoralists. Nonetheless, a few of the management practices including shortening of fattening period when drought was imminent and sharing of marketing costs with buyers of the fattened animals differed among the actors. The shortening of the fattening period was largely practised by the agro-pastoralists, given that they are more constrained by grazing resources as compared to ranchers and traders, while sharing of marketing cost with buyers was mostly practiced by the traders and agro-pastoralists. The difference in the sharing of marketing costs with buyers as a management practice may be explained by the variation in marketing strategies. Ranchers rarely shared marketing costs with the buyers, because they often sold their finished animals on the ranches, meaning the buyers would transport the animals to slaughterhouses or other terminal markets at their own cost. On the other hand, traders always sold the purchased animals as soon as they are finished to minimize costs associated with grazing fees, and therefore would prefer transporting them to market by themselves. This situation leads to the traders negotiating cost-sharing arrangements with the buyers. The agro-pastoralists however largely sell animals in the local markets and therefore shared market levies with buyers.

Conclusions
Stratified cattle production in the pastoral areas of Kenya involves fattening of mostly steers and bulls of Borana cattle, small East African Zebu and their crosses on natural pasture for 3–12 months, depending mainly on the availability of grazing resources and animal weight at purchase. Forms of SCP that vary with respect to access to grazing resources, herd sizes, classes of animals purchased, animal husbandry practices and fattening periods, exist in Kenya. The existing forms were adopted largely in response to drought occurrences and terminal market demands, but face challenges including high production costs, high marketing costs, disease outbreaks and fluctuation in animal market values. In response to the challenges, the SCP practitioners undertake management practices that are aimed at minimizing purchasing and production costs, and in the process maximize profits.

These practices comprise purchasing animals during a dry season when prices are low, using agents to source animals and bargain for better prices prior to market visits, purchasing mature animals that take shorter period to fatten, choosing flexible lease arrangements for grazing lands and shortening the fattening periods to.

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evade droughts. The results from this study are expected to guide interventions aimed at marketing of lean animals from pastoral areas through stratified production systems.

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Authors’ contribution
BHD carried out data collection, analysis and drafting of the manuscript. OVW, PI and BG supervised data collection and writing of the manuscript.

Conflict of interest declaration
The authors declare that they have no conflict of interest

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