Factors associated with level of income derived from working donkeys for smallholder farmers in the central highlands of Kenya

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Abstract

Few studies have documented the economic benefits obtained from working donkeys within the context of a highland agro-ecosystem. The objective of this study was to determine farm level factors associated with household incomes for farms that keep donkeys within smallholder farms in central Kenya. Data was collected using a semi- structured questionnaire administered to 351 donkey owners and users and analyzed using descriptive and inferential analysis. The results show that an average household owned three donkeys with a ratio of male to female donkeys estimated at 2:1. Majority (83%) of the donkeys were purchased into farms. Most households (98%) relied on donkeys as their primary source of income. The monthly gross margin obtained through commercial transport of goods using donkeys was 9,272 ± 41.7 KES implying a gross profit of 62%. The farm level factors that were associated with level of household incomes included the number of working donkeys reared per farm (P < 0.001), number of hours the donkeys worked (P = 0.05), savings from using own donkey transportations (P < 0.001) and engaging in crops (P = 0.017) and other livestock farming (P = 0.004). Alternative household income could be earned from the sale of donkey manure, hiring out of donkeys for work and sale of adult donkeys or their foals. Indirectly, use of own donkey for transport saved on transport and labor charges. These results call for a shift in attention on donkey health and welfare, which is ignored by livestock extension agents and policy makers in most farming systems across the developing world, where communities rely on donkeys as a source of subsistence for livelihoods.

Introduction

Livestock contributes to the livelihoods and food security of approximately 1.7 billion people in the World, particularly the rural and poor communities living in the developing countries (FAO, 1996). The contribution of livestock to Kenya's national GDP (Gross Domestic Product) is estimated at approximately 12% and 42% for the agricultural GDP (SNV, 2008). Income obtained through provision of draught power supports households in meeting the basic needs for survival such as food, clothing and shelter. However, provision of draught power has not been listed as a primary output for working equines (FAO, 1996), with contribution of working donkeys to the national GDP being under-represented by about 57% (IGAD, 2013).

The population of donkeys in Kenya is approximately 1.8 million, with Kirinyaga County raising approximately 3,990 donkeys. These donkeys are distributed throughout the administrative locations with high

concentrations being within the semi-arid, rural and selected peri-urban areas where they are used as an alternative means of transport (CBS, 2010). Within the rural areas, the donkeys are conveniently used as a means of transport when the conditions of roads become impassable during rainy seasons.

There has been a rapid growth of the population of donkeys raised within Kirinyaga County. For example, there were fewer donkeys in this region just about 30 years ago; which were primarily kept for transportation of farm produce to the urban market centers, but following the introduction of rice farming in Mwea region, and the increased businesses opportunities on ferrying of rice produce from farming fields to the milling centers, the use of donkeys has increased (Gachoki, 2018; personal interview). This increase in the number of working donkeys raised within the country under similar production systems in the central highlands has been argued to have resulted from increased intercommunity linkages through associations along various value chains where donkeys play some critical role in transportation (Njenga, 1993). In the recent past, however, donkey population sizes in the country have declined due to increased incidences of donkey theft for slaughter. This is due to the increased demand for donkey skin which is exported to China for use as an ingredient in the production of a herbal medicine known as Ejiao (Onono & Kithuka, 2020).

Although working donkeys contribute to both direct and indirect household incomes (Valette, 2015), they are not perceived as a critical element of people's livelihoods (Pearson *et al.*, 2000). Indeed, these working donkeys are often not considered with a lot of importance by policy makers, in part because they are perceived as single purpose animals (Hassan *et al.*, 2013). The perception of donkeys as hardy animals further complicates prioritization of health care provision for these donkeys posing health and welfare challenges which in turn affect their performance (Pearson and Vall, 1998). Furthermore, the prestige of owning donkeys is low in most societies with their ownership being often associated with communities living in poverty and state of marginalization (Fernando, 1997; Hassan *et al.*, 2013; Swai and Bwanga, 2008).

To date there is no reliable source of information on the factors associated with income from working donkeys raised by both by rural and urban households in the central highlands of Kenya. The objective of this study was to determine farm level factors that are associated with household incomes for farms that keep donkeys within a smallholder farming system in central Kenya. Results from this report are useful in guiding national policy development for inclusion of donkeys' health and welfare in the national planning and resource allocation framework, which would further provide a favourable working environment for donkeys and enhanced performance and productivity for donkey owners and users under similar production systems.

Materials and methods

Study design and area
This was a cross-sectional study conducted between the months of June to September 2018 in Kirinyaga County. The County borders Machakos County to the south, Murang'a County to the South West, Nyeri County to the North West and Embu County to the East. Mt. Kenya lies on its northern side. The county lies between 1,158 meters and 5,380 meters above sea level and is divided in three ecological zones; the highlands, midlands and lowlands. The lowlands are characterized by gentle rolling plains and cover land masses around Mwea East and Mwea West sub-counties. The county had a human population of 610,411 persons and covering an area of 1,478.3 km² (KNBS, 2019) with a donkey population of approximately 3,990 (CBS, 2010). Donkeys are raised within the lowlands where the Mwea irrigation scheme is located and some areas of the midlands where they are used as an alternative means of transport by farmers and local traders of agricultural products. The county is divided into five administrative sub-counties namely; Kirinyaga East, Kirinyaga West, Mwea East, Mwea West and Kirinyaga Central. The sub - counties are further subdivided to 12 wards, 30 locations and 81 sub-locations. Donkeys are raised in thirteen locations within the whole Kirinyaga County.

The County has a tropical climate with two rainy seasons. The long rains occur between the months of March to May with an average rainfall amount of 2,146 mm while the short rains occur between the months of October to

November with an average amount of 1,212 mm annually. The rest of the months experience a dry season.

The average land ownership in the county is one hectare for smallholder farmers (CIDP, 2018). Majority of the smallholder farmers' practice mixed crop and livestock farming. Farmers often lease land for a specific period of time from the National Irrigation Board which own most of the arable land in the lowland areas. However, in the highlands, individual land ownership is predominant (Ndegwa, 2014). Approximately 18% of households in Kirinyaga County obtain their income from self-employment though trading in different items such as farm and non-farm produce. Other households obtain their incomes from salaries and wages through formal employment or casual work respectively (CIDP, 2018).

The mixed crop and livestock farming is the most important economic activity practiced in the county. Approximately 87% of the population derive their livelihood support from mixed farming; which accounts for 72% of household income (CIDP, 2018). The other types of livestock kept by farmers include poultry, cattle, donkeys, sheep, goats, rabbits and bees, while agricultural crops which are grown include rice, maize, beans, tea, coffee, as well as horticultural crops: bananas, tomatoes and mangoes (KNBS, 2019).

Selection of study units

The study units were donkey owning households. The required sample size n of 351 was calculated based on a formula by Wayne and Chad (1999) where the population of donkeys was known. $n = (N \times X) / (X + N - 1)$. Where, $X = Z_{\alpha}/2^2 \times P \times (1-P) / p^2$; $Z_{\alpha}/2$ being the critical value of the normal distribution at $\alpha/2$ for a confidence level of 95%; α was 0.05 and the critical value was 1.96; p was precision or margin of error while P was the sample proportion, N was the population size (3,990) (CBS, 2010) and n is 351 donkey owning households whose owners were engaged in the individual interviews.

All the sub-counties were sampled proportionally based on the population of donkeys raised in each. Multistage sampling technique was employed to select the study units; first by selecting thirteen locations where donkeys were raised in the county and second by selecting the donkey owning households through systematic random sampling method by selecting every third household along a transect route. If a donkey was not found in the next selected household, then the next household was automatically selected for the study until a household with a donkey was found. The selected locations were Tebere, Gathigiriri, Nyangati, Murindiko, Kiamanyeki, Kamuchege (from Mwea East sub-county), Mutithi, Thiba, Wamumu, Sagana (from Mwea West sub-county), Kutus (from Kirinyaga Central sub-county), Ngariama (from Kirinyaga East Sub-county) and Kagio (from Kirinyaga West sub-county) (Table 1).

Table 1: *Number and proportions of households sampled per location*

Location	No. of households sampled	Proportion (%) of location	No. of donkeys owned in sampled households
Tebere	32	9	102
Gathigiriri	32	9	93
Nyangati	28	8	88
Murindiko	24	7	74
Kiamanyeki	25	7	78
Kamuchege	28	8	75
Mutithi	32	9	98
Thiba	32	9	92
Wamumu	25	7	79
Sagana	21	6	71
Kutus	24	7	62
Ngariama	24	7	53
Kagio	27	8	75
TOTAL	354	100	1040

Data collection

A total of 354 smallholder farming households keeping donkeys were interviewed using a semi-structured questionnaire with open and closed ended questions which was first pretested in different locations within the study site prior to data collection. The households were identified with the help of key informants who were well known members of the communities who also owned donkeys. They introduced the researcher to the household head and requested for consent to participate in the interviews. During the questionnaire survey, respondents were asked about; their age, land ownership, livestock numbers, donkey herd structure including the sex ratio, sources of household income, reasons for keeping donkeys, donkey working practices such as number of hours the donkey worked per day and the number of days donkey worked per week, hiring out of donkeys for a fee, considerations for working donkeys, husbandry and management practices and prices for various inputs used in donkey management, as well as alternative income generating activities. The questions were translated to Kiswahili language which was well understood in the study area.

Data management and analysis

Data from the questionnaires was first transcribed into a separate Microsoft Excel document. This was further exported to Genstat® (15th edition) statistical packages for analysis (VSN International, 2012). Qualitative data such as the reasons for keeping donkeys and sources of household income were ranked into 3 categories (1-3) using simple ranking and pair-wise ranking methods based on importance by the respondents.

The ranks were then converted to reciprocals to give weights to the obtained ranks. The analysis was accomplished using the Kruskall-Wallis One-way analysis of variance to test whether the median ranks were significantly greater than the median score.

The quantitative data was analyzed using descriptive statistical measures including mean, range and percentages.

The quantitative variables included the age group of the respondents, land ownership, herd sizes and herd structure, donkey working period in hours, number of working days per week, amount of daily income obtained from donkeys compared with other livestock, market prices for young and mature donkeys as well as market prices of various inputs and outputs incurred while working with donkeys.

The profitability of working donkeys was analyzed by calculating the gross margins and later presented as a percentage of gross income per household as profit margins. The gross margin was calculated using the equation proposed by Hook, 2006. Gross margin = Output – Variable costs.

While the profit margin was calculated using the formula recommended by Moran, (2009)

$$\text{Profit margin (\%)} = \frac{\text{Gross margin}}{\text{Gross farm income}} \times 100$$

Univariable general linear regression model was fitted in Gentat® (VSN International, 2012) to analyze farm level factors which were associated with level of income obtained from working donkeys in farms. The daily gross income obtained from donkeys was the outcome variable. It was regressed against factors such as: Number of donkeys reared per household, number of hours these donkeys worked per day, number of days donkeys worked per week, source of replacement stock for donkeys, land ownership, types of items transported, factors considered when costing for work done by donkeys as well as other alternative businesses farmers were involved in. The variables which were significant at ($P < 0.2$) upon univariable analysis were further analyzed using multivariable regression analysis, and for all cases a 5% significance level was applied. A regression model was then worked out based on the significant variables on multivariable regression. Since the selection of the households was dispersed, it was assumed that the responses obtained from the questionnaires were independent and the effect of clustering was minimal.

Ethical approvals and participant consent

Ethical approval to conduct the study was granted by the University of Nairobi; Faculty of Veterinary Medicine Biosafety, animal use and ethics committee. Permission to conduct the study was also obtained from the local

administrators before commencement of the study within their localities. Furthermore, before administration of the questionnaires, the study objectives were explained to the participants and verbal consent to participate in the interviews was granted from all the participants. The participants were assured of privacy and protection of their information especially on questions concerning money. No participant declined to give their consent.

Results

Determination of respondent and livestock demographics

Majority of the donkey owners and users were young people aged between 20-35 years (55%) followed by those between 36-50 years (40%). Few respondents were either below 20 years old (2%) or above 50 years old (3%). All the respondents from the selected households owned donkeys.

The total number of donkeys owned by the respondents was 1,040. The majority were adult males (65%), followed by adult females (23%) and foals (12%). The average small holder farming household owned 3 donkeys with a sex ratio of male to female donkey estimated at 2.1. The livestock species kept in addition to donkeys included cattle (34%), chicken (11%), sheep and goats (12%) as well as pigs (2%).

Majority (83%) of the donkeys were purchased into farms (294/354); while the other farmers (17%) either obtained their donkeys through farm breeding (32/354; 9%) or though both farm breeding and purchasing (28/354; 8%). The average market price for adult donkeys was 16,000 ± 252 KES. Adult female donkeys were bought at 16,551 ± 304 KES; which made them slightly more expensive than adult male donkeys whose buying price was 16,163 ± 200 KES. The average market price of foals was 8,000 ± 237 KES. Female foals were also slightly more expensive (8,529 ± 232 KES) when compared to male foals (KES 8,160 ± 242 KES).

Determination of reasons for keeping donkeys by households

The respondents considered donkeys as the most important livestock species (348/354; 98%) followed by cattle (6/354; 1.7%). This was because commercial donkey transport was a vital source of income for households (93%). The donkeys were also used for domestic transport, and as a source of manure, for supporting business activities, as a source of labour for farm work and to complement and assist in cattle farming. Donkeys were also kept because they had low cost of maintenance as compared to other livestock, and were also considered easy to work with and as pets (Table 2). The daily income obtained from working donkeys was estimated at 500 ± 42 KES compared to only 100 ± 23 KES obtained from cattle. Cattle were used both for their milk production and for ploughing.

Table 2: *Percentage scores for reasons of keeping donkeys according to farmers in Kirinyaga County*

Reasons for keeping donkeys	Rank 1	Rank 2	Rank 3
Source of income	93	8	14
Domestic transportation	7	52	34
Manure production	0	17	23
Little cost of maintenance	0	13	13
For sale (breeding of resale)	0	2	9
Support for farming activities	0	8	4
Raised as a pet	0	0	3

The manure from donkeys was sold at an average market price of 430 ± 26 KES per cart (estimated at 200 Kgs) which was equal to that of sheep and goats; but more expensive compared to manure obtained from cattle which was sold at 400 ± 85 KES per cart. And, the manure obtained from donkeys was used by 79% of all the respondents both for sale and for farm use.

The categories of donkeys that were allowed to work were the mature males (99%), mature females (62%) and foals (4%). A few pregnant animals were also allowed to work until they were either 7 months pregnant or were physically not able to work. The donkeys worked for an average of about 4 hours in a day (ranging from 1 hour to 10 hours) depending on the availability of work.

All donkeys were used for transportation of goods by pulling a cart. About 89% of donkeys worked in the dry season, 4% in the rainy season and 7% in both seasons. Different kinds of goods were transported such as water, rice, farm inputs and outputs, building materials, farm animal feeds and firewood.

The respondents considered the donkeys' ability to fit into a cart and being strong enough to pull the cart as important criteria to determine their suitability for work. The strength was determined by both body size (63%) and age (37%). Majority of the respondents however could not estimate the weight of donkeys. Since most donkeys were bought in, average sized adult donkeys weighing approximately 150 Kgs were preferred because they could be trained and then worked immediately upon acquisition.

When the donkeys were not working, majority were found grazing in communal land (74%) during the day. At night, some were left in the communal grazing areas overnight (21%) while others were either tethered in their homesteads (23%) or housed under unroofed (23%) or roofed (6%) enclosures. Others were untethered within the homesteads (19%) while a few (8%) roamed freely around the urban centers. Majority 57% (202/354) of the donkey owners leased land. Others used their parents land (24%) while a few rented land (19%). Majority (91%) of the tethered donkeys within the homesteads were allocated a space of between 10 to15 feet radius. The space allocated for the enclosures was about 10 feet by 25 feet. These enclosures were shared among donkeys and cattle.

Majority of the owners did not incur labour charges since most of the respondents (90%) worked with their own donkeys. Those who hired labour paid the laborers a fraction of the income obtained. This ranged from a third of the gross income obtained (30%), a quarter (6%) and a half (16%) of the money earned from donkey transport. Other households paid between 200 KES and 500 KES as labour charges per day.

Description of sources of household income
Livestock farming was an important income generating activity among smallholder farmers in the highland areas of central Kenya. Commercial donkey transport was a source of income for 98% of households. Other alternative sources of household income for the smallholder farmers included mixed crop-livestock farming involving cattle, sheep, goats, poultry, pigs and food crops. Income was also obtained through motorbike transport, salaries and wages through formal employment or casual work (Table 3). The daily income obtained by households though commercial transport services using donkeys was 500 KES (range of 0 KES to 3,000 KES). This was higher than the average income obtained from other livestock such as cattle, sheep, goats and chicken (100 ± 23 KES). While the average daily income obtained from crop farming was only estimated at 250 ± 16 KES. The highest source of daily household income was through salaries and wages (1,500 ± 65 KES) although very few (1.4%; 5/354) small holder farmers were employed. The daily costs incurred during working with donkeys included feeding cost (87 ± 9 KES), watering charges (22 ± 2 KES) and treatment charges (19 ± 2 KES). Therefore, the daily gross margin obtained through commercial transportation of goods using donkeys was therefore 300 KES.

Table 3: *Percentage sources of household income according to farmers in Kirinyaga County*

Household income	Rank 1	Rank 2	Rank 3
Donkey transportation	99	2	1
Other livestock farming	0	85	75
Crop farming	1	3	20
Salary and Wages	0	8	3
Motor Bike transportation	0	2	1

Determination of profitability from working donkey

Profitability of working donkeys was determined by subtracting variable costs from the monthly gross income obtained through commercial transportation of goods using donkeys 15,000 KES (500×30). The types and costs of variable inputs incurred included purchase of feeds and feeding (2,618 ± 264 KES), water (652 ±63 KES), charges for communal grazing at night (600 ±64 KES), treatment of diseases (583 ± 56 KES), maintenance of the cart (896 ± 89 KES) and hiring charges where applicable (379 ±16 KES). Based on these costs and outputs from donkey rearing, the estimated monthly gross margin was 9,272 ±42 KES (approximately 300 KES per day); which was about 62% of the gross income from working donkeys.

Analysis of factors associated with level of income for working donkeys

Univariate analysis using Genstat generalized linear regression identified various household factors that affect income from working donkey. These included the number of donkeys reared per farm, the number of hours these donkeys worked, hiring out of donkeys, savings from using own donkey transportation as well as engaging in mixed farming though farming in crops and other animals. Other factors which were significant although negatively included purchasing donkeys into farms, transportation of water and charging lower than peers (Table 4). The significant factors on multivariable regression analysis which were associated with level of income from working donkeys included the number of working donkeys reared per farm, number of hours the donkeys worked as well as engaging in alternative sources of income generating activities such as mixed crop and livestock farming as well as savings from using own donkey transportation (Table 5).

Table 4: *Univariable analysis for factors associated with level of income from working donkey*

Parameter	Estimate	S.E	*P* Value
Total number of working donkeys per household	90.3	17.2	<0.001
Number of hours that donkeys work in a day	38.6	12.5	0.002
Use of parents' land to rear donkeys	80.7	51.7	0.120
Use of own land to rear donkeys	-51.9	56.4	0.358
Source of donkeys: purchased	-166.3	81	0.042
Source of donkeys: farm bred	-153	106	0.149
Hiring out of idle donkeys	102.3	73	0.162
Charging lower fees than peers (caused a decrease in income)	-241.0	154.	0.118
Alternative Sources of income such as;			
- Domestic transport	368.	108.	<.001
- Other livestock farming	571.	163.	<.001
- Crop Farming	192.7	59.6	0.001

Parameter	Estimate	S.E	P Value
- Casual work	155.7	81.0	0.055

Table 5: *Multivariable analysis for factors associated with level of income from working donkey*

Parameter	Estimate	S.E	*P* Value
Constant	*153.4*	*75.4*	*0.043*
Number of working donkeys	93.7	17.9	<.001
Number of hours the donkey works	23.7	12.5	0.050
Alternative sources of income			
- Savings from own donkey transportation	412.	112.	<.001
- Other livestock farming	456.	157.	0.004
- Crops farming	142.0	59.8	0.017

Proposed model for farm level factors associated with income from working donkeys

The proposed model for describing farm level factors that were associated with income from working donkeys was:

$Y = b_0 + b_1 X_1 + b_2 X_2 + b_3 X_3 + e$

Where Y = Income from working donkeys, b_0 = the intercept, X_1 = Number of working donkeys, X_2 = Number of hours the donkey works, X_3 = Alternative sources of income and e = residual.

Discussion

Purchasing working donkeys from other regions in a male to female ratio of 2:1 coupled by the few foals reared by the small holder farmers threatened donkey herd continuity in light of the present challenge of donkey theft in Kenya. Male donkeys were preferred during purchase because they were perceived to be hardier and stronger than female donkeys as observed in Bostwana. Further, the female donkeys were more disadvantaged due to the lost working days during the peri-parturient period (Greiger and Hovorka, 2015). Female donkeys were, nonetheless, more expensive than the males due to their additional use as breeding animals besides provision of draught power. This higher price could however influence the preference for male donkeys in the study area.

On average, 3 donkeys were raised per household in Kirinyaga County. This ownership level was higher than Ethiopia which had an ownership of 2.39 donkeys per household (Melkam, 2017) in a similar small holder farming setting. This could be due to the type of cart used in Kirinyaga County that is designed for 3 donkeys. The small holder farmers kept donkeys as important livestock in their farms for their contribution to household income.

In the present study, the surveyed respondents preferred to keep donkeys rather than cattle because donkeys were cheaper to buy from the markets. Donkeys were also cheaper to maintain in terms of lesser feed, water, grazing area and treatment requirements. Handling and restraint of donkeys was also easier compared to cattle. This scenario was the same as for Northwest Nigeria where mixed livestock farming was practiced under a similar small holder setting (Hassan *et al.*, 2013). The responses could however be biased since only donkey owning households were selected for the study.

8

When donkeys were not working, they were found grazing in communal grounds (74%) often with other livestock. This provided a good opportunity for social interaction (Moyo *et al.*, 2008). Untethered donkeys were often found roaming within the urban centers; which posed the risk of theft and road accidents. An enclosed communal grazing area with adequate feed and water was therefore proposed though collective efforts by small holder farmers to ensure their donkeys were safe within the urban areas. Within the farms, mostly at night, donkeys were tethered within a radius of between 10 and 15 feet. The space allocated for the enclosures occupied an area of approximately 10 feet by 25 feet depending on the number of donkeys owned. Donkeys were mostly housed together with cattle within the enclosures. This space allocation was relatively small corresponding to the small farm sizes of 1 Ha for small holder farmers in central highlands of Kenya (CIDP, 2018).

Land ownership as a farm level factor was not associated with income from working donkeys in the present study. In Nigeria, under a similar small holder setting, land ownership was negatively associated with income from donkeys (Hassan *et al.*, 2013). Land was therefore not a necessary factor of production in donkey farming. Indeed, 19% of small holder donkey farmers were landless and had migrated to the region to provide commercial transport services using donkeys due to urbanization in Kirinyaga County (Gachoki, 2018; personal interview). This category of donkey owners either left their donkeys to graze within the communal land or released their donkeys to roam around the urban centers at night. Majority (81%) of the others who either purchased their land or used their ancestral land controlled their donkeys within the homestead at night either by tethering or enclosing them; although a few still left the donkeys in the communal grazing areas.

A study by Fielding and Krause (1998) showed that one pack donkey could safely carry one-third to one –half of its own weight over several hours if it is in reasonable welfare. On the other hand, one donkey pulling goods by cart could pull about 2.7 times of their live weight (Gebresenbet *et al.,* 2016). The cart used in Kirinyaga County is designed for 3 donkeys. Given that the household ownership of donkeys is three, more weight could be pulled by 3

donkeys per trip without compromising on their welfare.

Most donkeys in Kirinyaga County worked for an average of 4 hours per day. Longer working hours of 6 hours have been recorded by Gebresenbet *et al.*, (2016), but with lighter load weights. The number of hours the donkeys worked was a significant farm level factor associated with income earned from working donkeys in the present study ($p < 0.05$) and in a previous study by Hassan *et al.*, (2013). The donkey owners had adequate time to engage in additional income generating activities such as crop farming, motorbike transport and casual work.

Within the central highlands of Kenya, donkey feeds included hay and straw from the fields, crop residues such as cabbages from the markets, feed wastes from other animals as well as grazing on natural pastures. A few donkeys were also fed with concentrates such as rice bran, maize bran or maize germ from the milling companies. These were offered to the donkeys based on the owner's ability to purchase the concentrates. The variety of feeds caused the price of feeds, feeding and watering to be manageable at 109 ±13 KES per donkey per day. The costs associated with feeding and water contributed to 54% (109/200) of the variable costs in donkey farming which was within the range (50-60%) indicated for cattle production (Moran, 2005).

The average cost of health care was estimated at 583 ± 56 KES per donkey per month (19 ± 2 KES per donkey per day). Health care was provided by Local Animal Health Providers (LAHPs) who were preferred because they had improved competencies in treatment and management of donkey diseases and conditions (Gichure *et al.*, 2019; and Onono, 2017).

The gross daily income of 500 ±42 KES (with a gross margin of 300KES) per donkey was sufficient to support farming households. This was above the international poverty line which was US$1.9 (194 KES) (1US $ =102.6 KES) (World development report, 2019). The monthly gross margin of 9,272 KES was comparable to wages of many informal full-time jobs in Kenya (KNBS, 2019). Income from the working donkeys was adequate for the donkey farming households in the study area. Changes that could reduce the population of donkeys within the central highlands of Kenya, such as theft of

donkeys, may well affect the incomes and hence survival of these small holder farming households.

Majority of the respondents worked with their donkeys themselves (90%). In the past neighbours' donkeys were freely accessible in areas such as Ethiopia and Limuru (Kenya) (Njenga, 1993). In the present study, donkeys were hired out at a fee. Many of the respondents stated that hired donkeys were often returned in a poor welfare state, having user inflicted wounds and injuries, and necessitating owners to incur treatment costs thereby reducing the net profits earned. The welfare compromise appears universal as previous reports recommended studies on welfare of hired out donkeys (Valette, 2015). Those who hired out their donkeys within the study are did so to responsible users who spared the whip and were keen to observe early signs of diseases. A proper hiring system would encourage small holder farmers to own more donkeys due to the alternative income earned through hiring of donkeys. Those who hired out their idle` donkeys earned two-thirds of average daily income. In other parts of Africa such as Botswana, hiring fees depended on the distance covered by the donkeys when working (Aganga and Maphorisa, 1994).

In addition to income from transport of goods, gross income from working donkeys could be increased through hiring out of donkeys (2/3×500=360 KES), sale of manure from donkeys (at 430 ±26 KES per bag), and sale of foals or adult donkeys (at a market price of 8,000 ± 237 KES and 16,000 ±252 KES) as replacement stock. Manure yield could be increased through accumulation enabled by enclosing or housing of donkeys (Ndambi et al., 2019)

This study presents the first findings that describe the characteristics of working donkeys and the farm level factors associated with generation of income from working donkeys under small holder farming systems in the central highlands of Kenya. The study has demonstrated the crucial economic role played by donkeys among small holder farmers in Kenya as in Nigeria (Hassan et al., 2013), where donkeys earn income for households and create employment opportunities. Mixed or sole smallholder donkey farming can therefore realize sufficient income for farming households in Kenya as reported to do in Australia (Corowa, 2016).

Healthy donkeys in a state of good welfare and nutrition are more productive in terms of sustained work output and produce more foals (Pearson and Vall, 1998, Ram et al., 2004). This translates to increase incomes from the working donkeys. Although disease occurrence among donkeys is generally low, access to affordable veterinary care remains a challenge to most donkey owners (Onono, 2017).

Although this was a cross-sectional study in one county of Kenya, further studies should be conducted in different counties under different production systems to identify more factors associated with the level of income from working donkeys as well as to determine the profitability of working donkeys in these areas.

Policy makers, extension agents and animal health practitioners in donkey farming counties should intensify efforts towards improvement of donkey health and welfare as an important avenue to safeguard the livelihoods of many small holder farmers who depend entirely on donkeys as their source of household income. Small holder farmers should also improve the donkey husbandry practices to ensure the donkeys work efficiently to sustain the household incomes earned through them.

Conclusion

In conclusion, the farm level factors that were associated with level of household incomes included the number of working donkeys reared per farm, number of hours these donkeys worked, savings from using own donkey transportations as well as engaging in mixed crop livestock farming. The estimated monthly gross margins obtained though working donkeys was 9,272 ± 41.7 KSH implying a gross profit of 62%. Alternative household income could be earned through donkeys from the sale of donkey manure, hiring out of donkeys for work as well as sale of adult donkeys or their foals as replacement stock.

The health and welfare of the working donkeys should be improved through collaborative efforts by policy makers, extension agents, animal health practitioners and donkey owners in order to improve the living standards of the livelihoods of the 98% of donkey owning households who entirely depend on donkeys as a means of sustenance.

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